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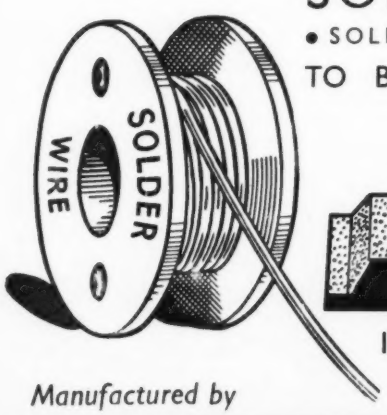

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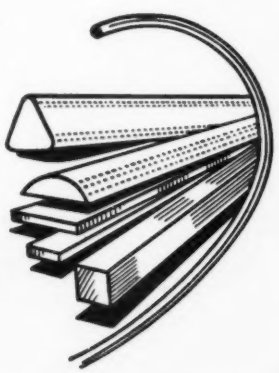

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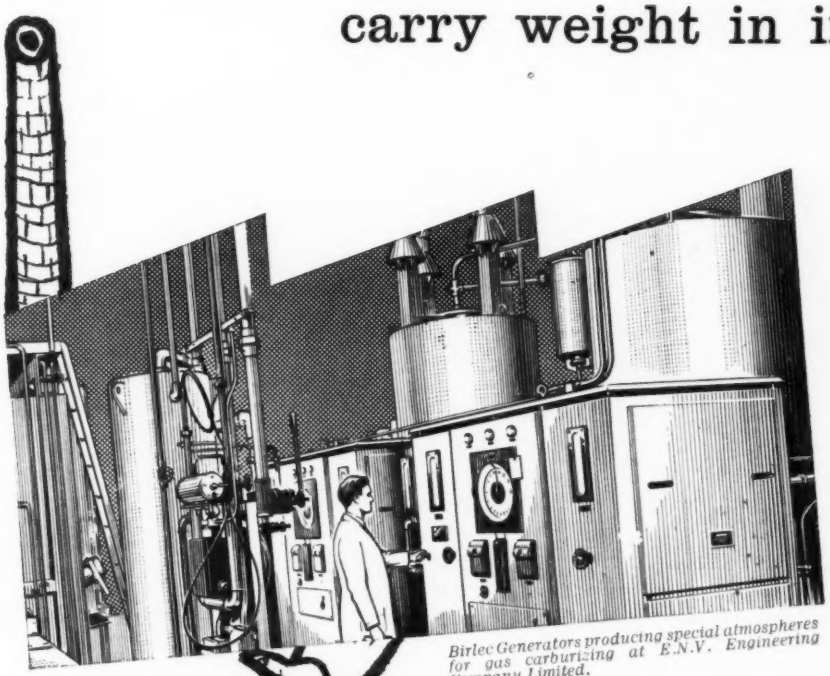

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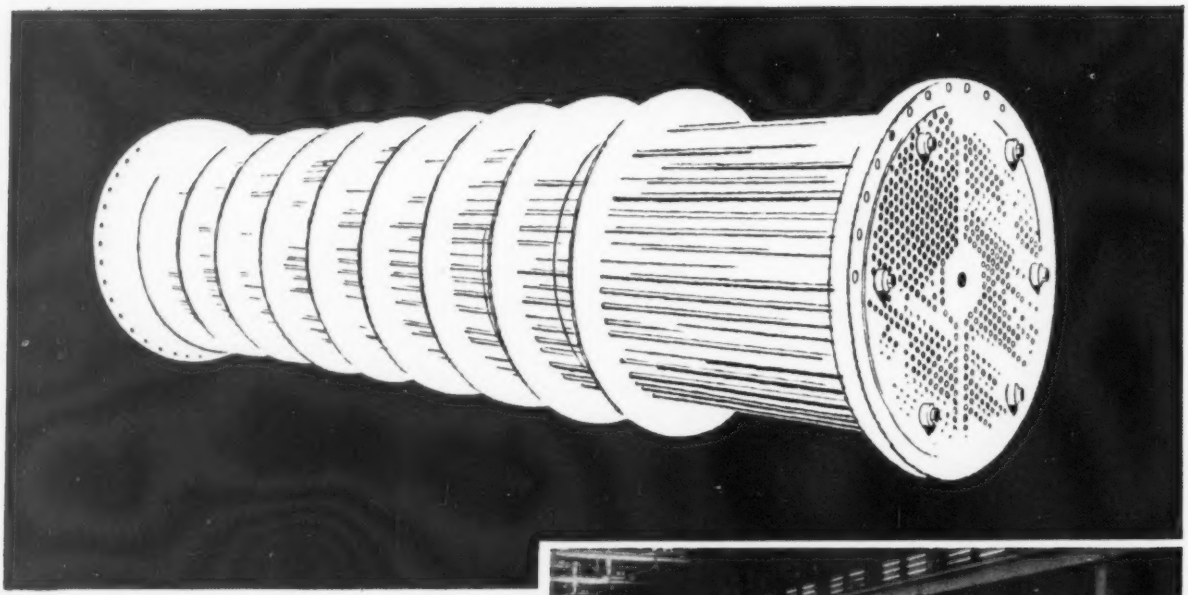

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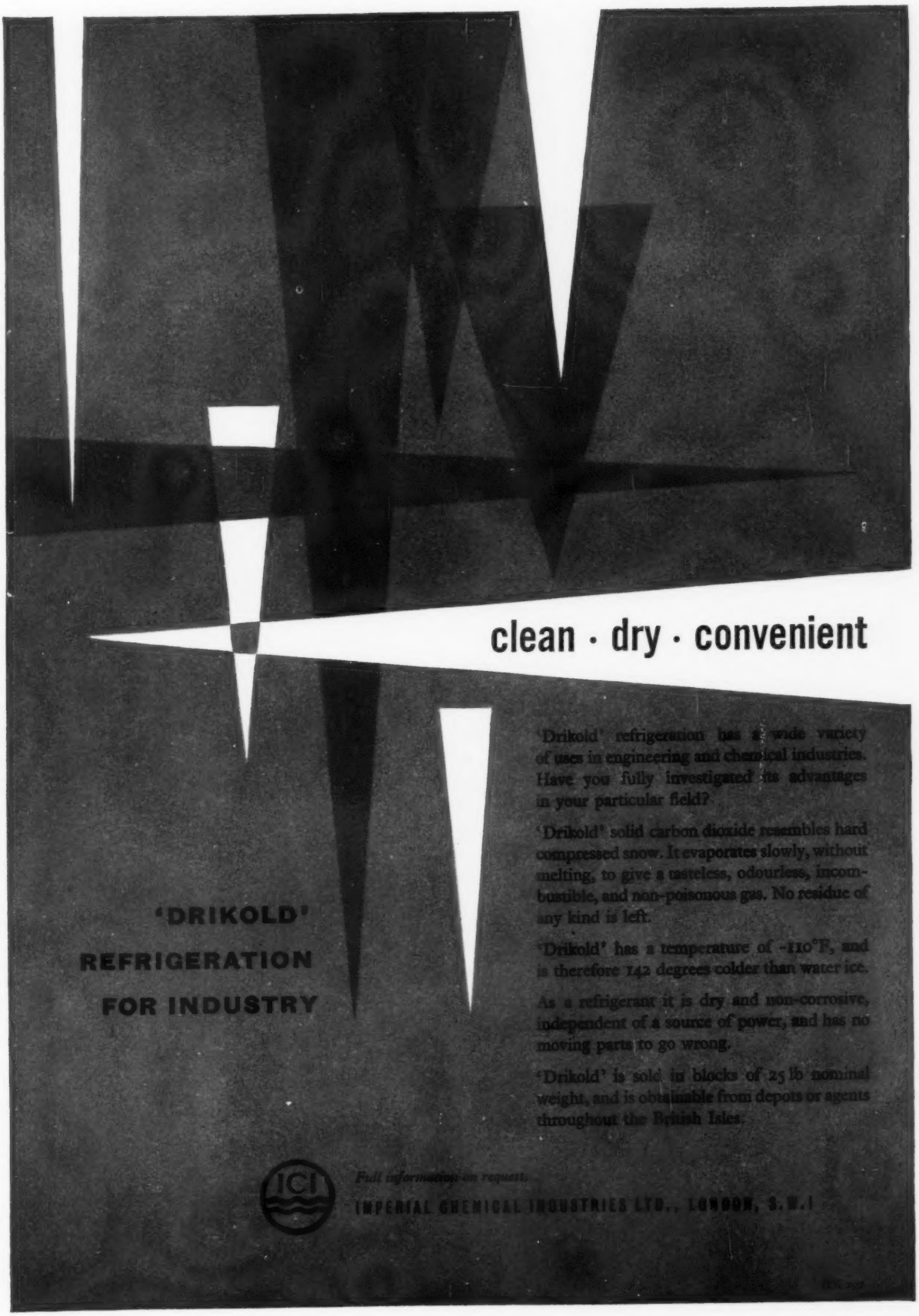
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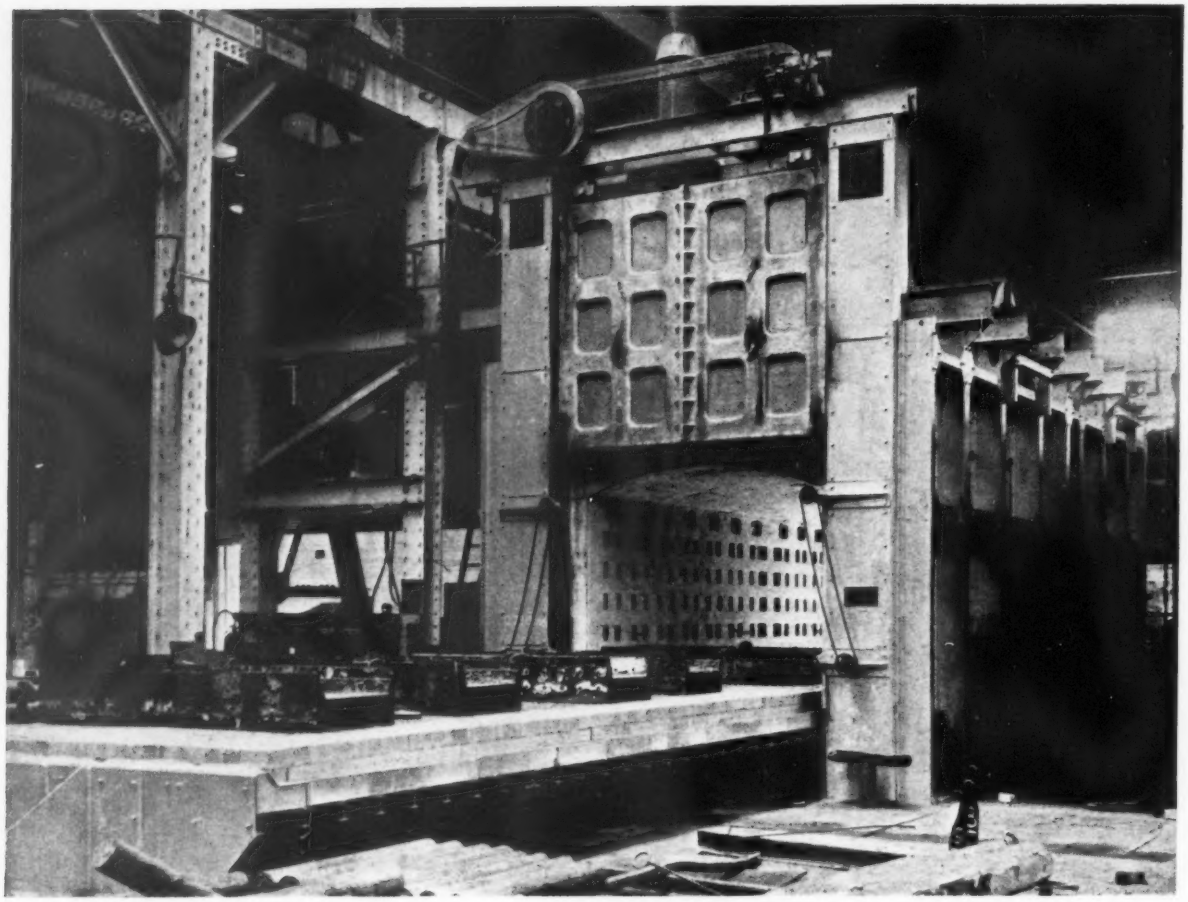

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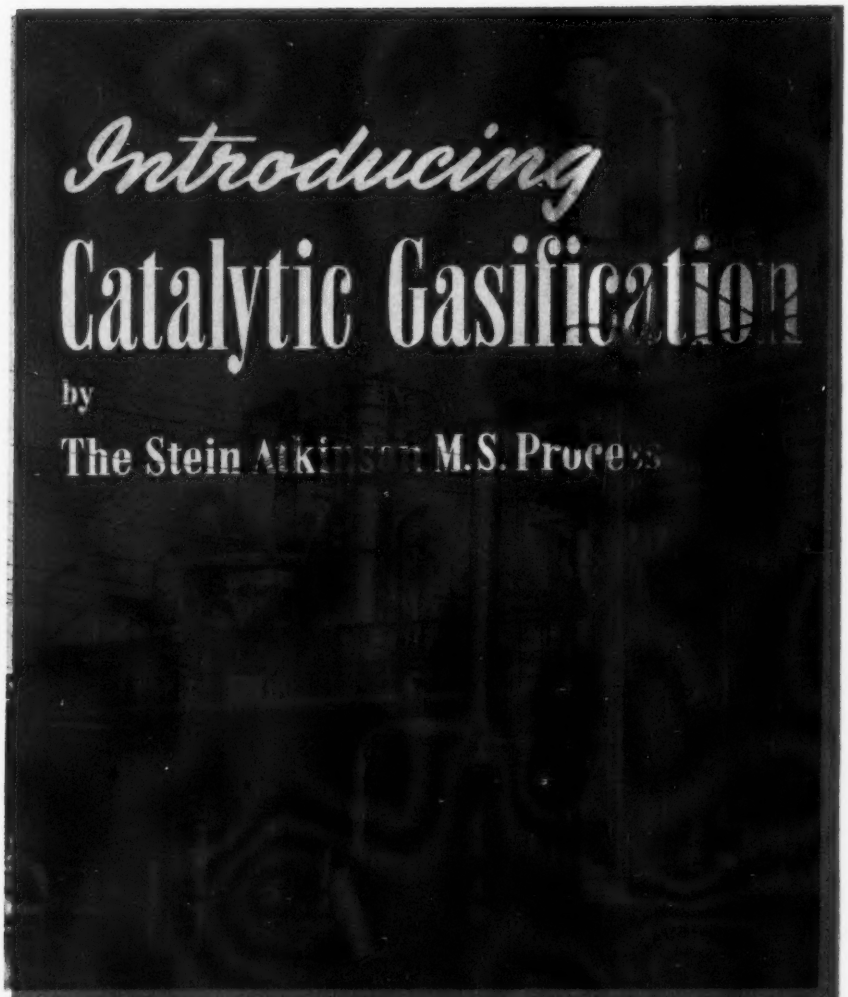

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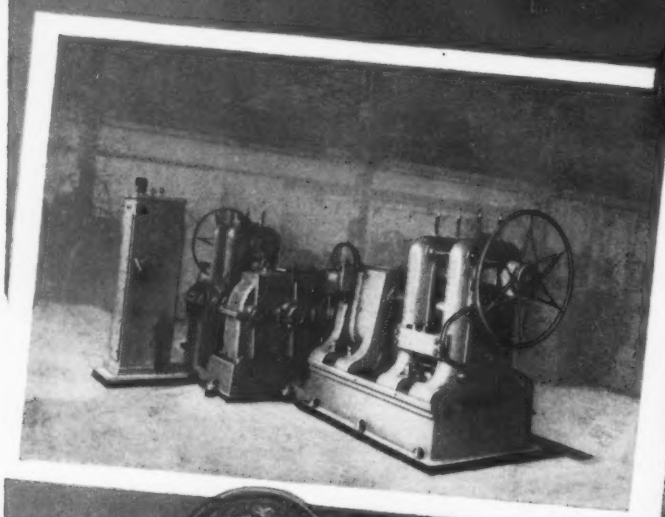

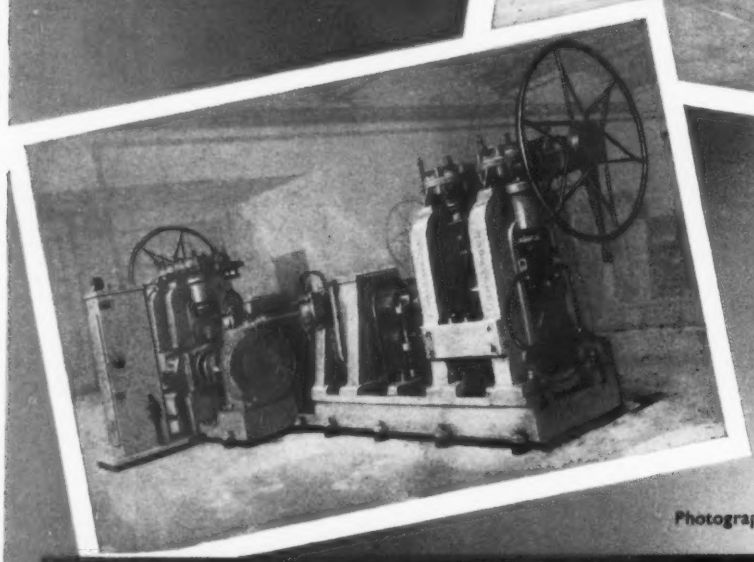

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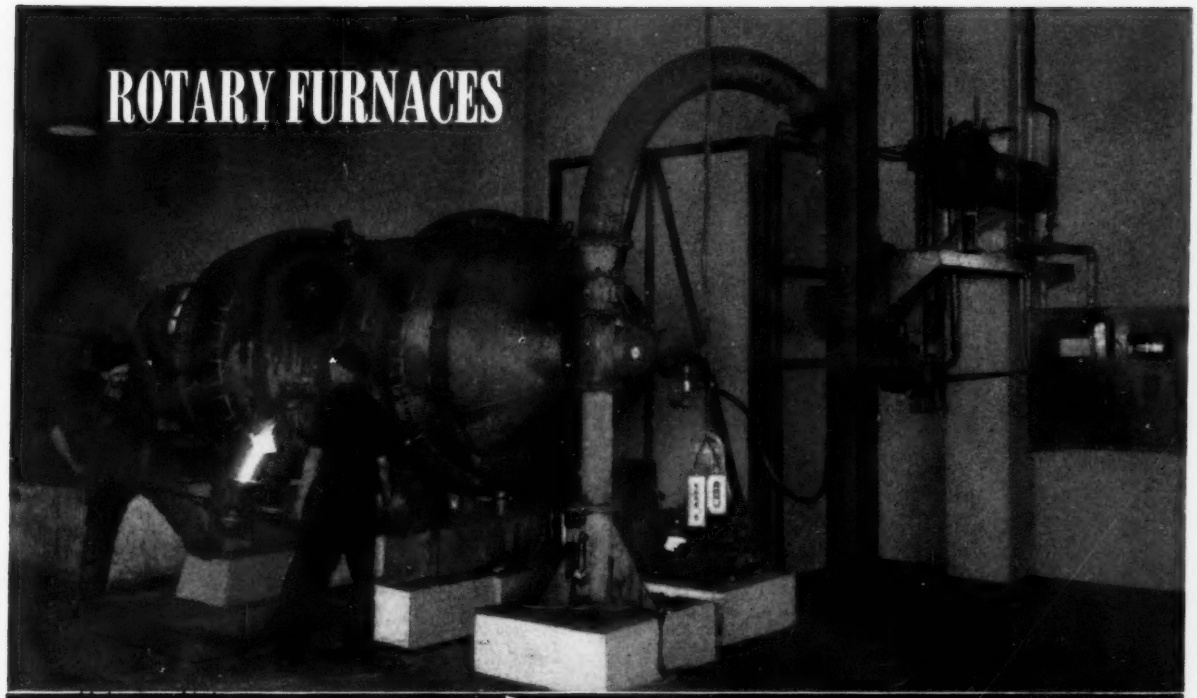

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METAL INDUSTRY

FOUNDED 1909

EDITOR: L. G. BERESFORD, B.Sc., F.I.M.

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METAL INDUSTRY

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National Chemical Laboratory

REALIZING that the old title of Chemical Research Laboratory implied that its work was confined to and covered the whole field of chemical research, whereas the actual researches are concerned with only a selected number of problems, the more appropriate title of National Chemical Laboratory has now been adopted. The functions of the Laboratory are to carry out chemical researches of a fundamental nature, to undertake basic chemical researches of wide general application to many industries, and to carry out chemical researches of an objective nature for industry on repayment. The Laboratory will also prepare, maintain and supply for use as reference standards, samples of pure materials such as metals. An indication of the effective manner in which these objectives are being achieved can be found in the recently published report for the year 1958. One further point of interest is that the specialized knowledge accumulated by the research teams is made freely available, and a large number of enquiries are received for advice and assistance on all topics related to the work of the Laboratory. In addition, advice is often sought on topics quite outside the scope of its researches. The largest number of enquiries concern the corrosion of metals and techniques for the purification of organic compounds.

Many examples of the work of the Laboratory in connection with metals are quoted. Thus, methods for the extraction and recovery of uranium from a variety of ores have been studied. Detailed tests have been carried out on the solvent extraction of thorium using a branched chain amine, Primene JM-t, which has the ability to extract thorium selectively from a solution containing a very large excess of ferric sulphate without previous reduction of the iron to the ferrous state. Two other methods of thorium extraction have also been studied, namely precipitation with oxalic acid and adsorption on phosphorylated cellulose. While all work on the extraction and recovery of thorium from ores has now been terminated, investigations into ion-exchange methods for the recovery of gold and other metals from solution as cyanide complexes have continued, emphasis being laid on the economic factors governing the operation and application of the process. Chemical methods for the extraction and concentration of beryllium from low grade ores and flotation concentrates are also being studied with the object of obtaining an economic process for utilizing these materials as a source of beryllium.

Highly pure metals are of paramount importance in many branches of modern industry, for example as semi-conductors, and a stock of some twenty-eight metals is now held and maintained by the Laboratory, methods of purifying metals still being the object of further study. Thus, while purification of lead to an extremely high degree by zone refining has been claimed, experiments carried out by the Laboratory suggest that the process is much less effective than with, for example, bismuth or antimony. On the other hand, preliminary results of an investigation into the further purification of super-pure grade (99·99 per cent) aluminium by zone melting indicate a reduction of the iron, copper and zinc contents to the order of 1 p.p.m. Rare earth metals, while detected in the original material, were not found in the refined product. There appears, however, to have been little or no reduction of the silicon and magnesium contents. Study of the behaviour of zinc in ingots of cadmium subjected to zone melting gave erratic results, which was probably attributable to the volatility of zinc. Fusion of the cadmium under caustic soda for ten minutes gave practically complete removal of the zinc. Zone-melted cadmium, however, showed marked segregation of lead.

Out of the MELTING POT

N.B. METALLURGISTS, fully occupied with problems and developments in their own field, have the understandable but nevertheless unfortunate habit of overlooking or dismissing developments concerning metals in other fields, in particular in the chemical field. Thus it will be sufficient to mention that a new, promising application of aluminium powder, now developing, is to be found in the field of solid propellants, for the matter to be dismissed as being of little or no metallurgical interest. It so happens, however, that in this particular instance this dismissal is liable to tip out, as it were, an interesting and undoubtedly metallurgically-legitimate baby with the bath water. This baby—the metaphor is appropriate in more senses than one—is the ultra-fine aluminium powder and the process for producing it developed specifically in this connection. Samples of spheroidal aluminium powder with particles from 80 down to 20 millimicrons are now becoming available. Production processes are naturally not for publication as yet, but are understood to include high-intensity arc processes, and the spraying of molten aluminium into a vacuum chamber with helium or argon. The incorporation of this material into solid propellants and the magnitude of the resulting bangs can be left to those concerned with such matters. It is to be hoped, however, that adequate interest will be forthcoming to ensure that any crumbs (particles) of the material that may fall from the classified military table will be picked up and examined by metallurgists, with more lasting objectives in view. A successful or even merely promising outcome of any such efforts might well serve to stimulate the trying out of the special production processes with metals other than aluminium.

Hopeless ? SOME of the early enthusiastic accounts of the cold-chamber pressure die-casting process, when they came to speculate on the condition of the metal being injected into the die, made much of the assumption that at that stage the metal had already cooled to a degree at which partial solidification had already taken place, the metal entering the die in a mushy or pasty condition. Some of these speculations were, indeed, carried to the extent of claiming for this form of die-casting some of the features and benefits of the hot forging process. Indeed, where descriptions of the process being used conveniently omitted essential details, it was sometimes impossible to decide whether the metal was, in fact, being cast or forged. The demarcation line between the two processes, on the approach from the molten metal side, thus tends to be ill defined, although, so far as the processes themselves are concerned, they have, in more recent years, settled down in their respective recognizable niches. This matter of the demarcation line is quite different when the approach is made by heating the solid metal. Along that line of approach, the boundary is quite definite and allegedly impassable. The slightest trace of incipient melting is sufficient for the metal to be regarded as "burnt" and thereby utterly ruined. The dread of suffering this calamity is so great that hot working temperatures are usually set with a generous margin of safety applied to the upper limit. Given this ingrained fear, a good deal of courage and a large dose of optimism will be necessary before a programme on the hot working of metals at temperatures beyond the incipient melting point is embarked upon. Without them, the prospects of such a programme will at once be put down as hopeless. Given the development of appropriate techniques, and of the appropriate alloy compositions which may well be required, and a broad view of the potentialities of the resulting products, however, need they be quite hopeless?

No Effect NOTHING being perfect, the assumed perfection of metal whiskers, to which their characteristic exceptionally high elastic yield strengths, sharp yield points and low plastic flow stress were originally ascribed, has not been allowed to survive for long. Thus, the perfect freedom from dislocations has been replaced by what was thought to be a more realistic state of affairs: the presence of dislocations which are immobilized in some way. Additionally, it was suggested that, in view of the large surface area to volume ratio of whiskers, surface effects on strength might be quite important. All this brought whiskers practically down to the level of ordinary conventional metallic specimens. Indeed, so far as surface effects are concerned, the similarity is complete, in that in both cases there is evidence to the effect that surface factors both are and are not significant. Thus, results have been obtained showing that in the case of zinc whiskers the observed yield strength is a function of the thickness of the oxide film on the crystal surface, maximum strength being attained with a film thickness of from about 10Å to 100Å. There have also been experiments in which whiskers of copper and silver, tarnished by prolonged exposure to the laboratory atmosphere, were tested in bending before and after cleaning. The tarnished whiskers exhibited the characteristic high yield strength and eventual abrupt local yielding to form a sharp kink. The whiskers were cleaned by cathodic treatment, in hydrochloric acid in the case of copper and in sulphuric acid for silver whiskers. Sufficient current was passed to reduce the copper oxide and silver oxide or silver sulphide of the tarnish films. In all cases, cleaned whiskers were found to have approximately the same elastic strength as the whiskers that had not been cleaned, and no systematic increase or decrease was detected. This is in line with the finding that gold whiskers, which should be free of surface oxide, are characterized by the same exceptionally high strengths as other metal whiskers. While all this does not, of course, rule out the possibility of effects of adsorbed films, it does strengthen the impression that the characteristics of metal whiskers are due to a fortunate (optimum) interrelation between the shape and size of the whiskers and the distribution, density and type of dislocations present.

Skinner

REVIEW OF BRITISH AND AMERICAN INFORMATION

Aluminium-Copper-Silicon Casting Alloys

By J. RIDLEY, B.Sc.(Eng.)Met.

Existing information on the properties of aluminium-copper-silicon casting alloys has been surveyed in this contribution from the British Non-Ferrous Metals Research Association, and the results of the survey are presented largely as contour diagrams

ADDITIONS of 1-3 per cent silicon to aluminium - copper casting alloys yield a material more resistant to hot tearing[1,2] though with tensile properties lower than those of D.T.D. 304. As its susceptibility to hot tearing is the principal disadvantage of this high-strength alloy, the effects of silicon additions appeared to warrant detailed examination.

Alloys of aluminium containing copper and/or silicon as major alloying elements have for a long time formed the basis of light alloy castings. Binary alloys containing copper were used for their high tensile properties, particularly after heat-treatment, while those containing silicon, although inferior to aluminium-copper alloys in strength, had superior casting characteristics and resistance to corrosion. The more complex aluminium - copper - silicon alloys developed later as secondary materials exhibited some of the advantages of both alloying elements, and to-day the general-purpose alloys based on this system comprise the majority of aluminium casting alloys.

The information published in recent years on the influence of composition in these secondary alloys forms the basis of this article. The possible development of a high-strength aluminium - copper - silicon alloy has been kept in mind throughout, however, and for comparison the properties obtainable with the existing high-strength alloys have been listed in Table I.

Factors other than composition markedly influence the properties of the alloys under review, and these will be discussed later. Results from various sources therefore differ, and a distinction has been drawn throughout this report between the results of tensile tests drawn from British and American sources, and also between results for sand cast and chill cast alloys. Where possible, contour diagrams have been drawn, but the information available has been too scanty in some cases.

Factors other than Composition

Freezing rate and section thickness. The high rate of solidification associated with chill casting and with small section thickness produces a fine microstructure and, under some conditions, a small macro-grain size, each of which encourages high tensile properties.

For this and other reasons, test-bar design has a significant influence on the properties obtainable. The standard tensile test bar used in this country for aluminium alloys, the D.T.D. bar, is 1 in. diameter when cast and is subsequently machined to 0·564 in. diameter; in the U.S., on the other hand, a cast-to-size, shaped test bar of 0·5 in. diameter is used which is tested with the cast surface intact. As the size and shape of the latter bar permit more rapid solidification and better feeding, the tensile properties quoted for a given alloy in the U.S. are often higher than those reported in this country.[11]

Grain size. The beneficial influence of a fine grain size on tensile properties is very marked for high-strength casting alloys free from large quantities of embrittling constituents.[12] This grain size effect is due largely to changes in the form of microporosity, and to a lesser extent to a reduction in volume of porosity.[13]

Because of its influence on porosity, grain refinement improves pressure tightness,[13] and fine-grained materials are also less susceptible to hot tearing than the corresponding coarse-grained materials.[14,15]

The effects of variations in grain size can be marked and it is unfortunate that grain sizes are rarely included in published information. The results quoted below are for materials assumed to have moderately fine grain sizes.

Casting Properties

Hot tearing. Susceptibility to hot tearing is largely a function of alloy constitution and is most pronounced in alloys which freeze through a wide temperature range after becoming semi-coherent. In a series of hypo-eutectic compositions, maximum susceptibility can be correlated with the presence of a critically small proportion of eutectic in the microstructure; larger proportions of eutectic not only reduce the tendency for cracks to form, but also heal many of the tears.[9,14,16]

Jennings, Singer and Pumphrey[1] compared the cracking tendency of aluminium-copper-silicon alloys, using a restrained ring casting. The results (Fig. 1a) indicate that maximum susceptibility to cracking occurs at very low alloy contents.

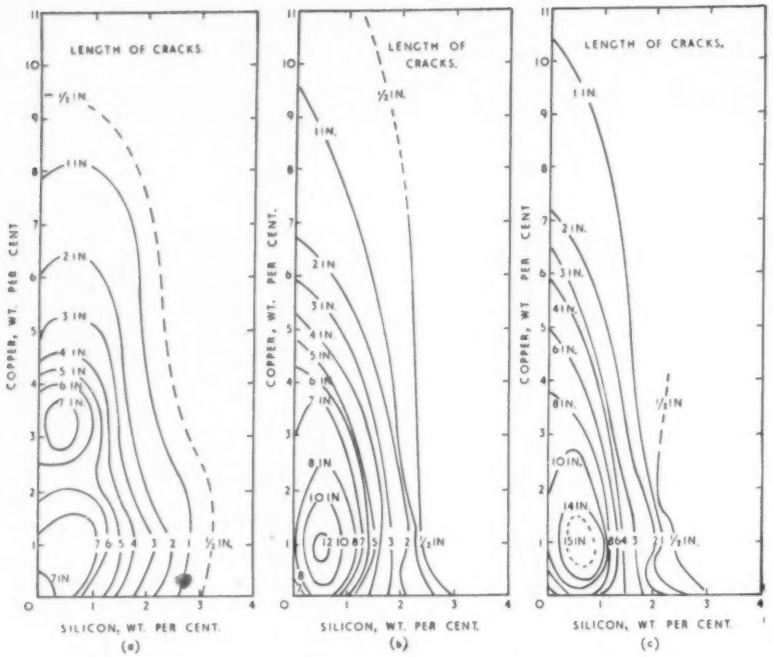
Cracking tendency falls sharply with copper content in the range 4-5 per cent, and is approximately halved (according to the scale of this test) by an addition of 1½ per cent silicon. Alloys containing more than 3 per cent silicon have a low susceptibility to hot tearing, whereas in the absence of silicon nearly 10 per cent copper is required to reduce hot tearing to the same extent.

From other results given by Pumphrey,[9] cracking diagrams for aluminium-copper-silicon alloys containing 0·2 and 0·5 per cent magnesium have been constructed (Figs. 1b and c). These show that increasing amounts of magnesium increase the susceptibility to hot tearing at low alloy con-

TABLE I—PROPERTIES OF HIGH-STRENGTH ALUMINIUM CASTING ALLOYS

Alloy		Typical Tensile Properties†								Corrosion Resistance ††	Hot-Tearing Resistance**
		Sound Test Bars						Moderately Fed Sand Castings (0·7% Porosity)			
		Sand Cast			Chill Cast						
Type	Composition (%)	Tensile Strength (tons/in²)	0·1% Proof Stress (tons/in²)	Elong. (%)	Tensile Strength (tons/in²)	0·1% Proof Stress (tons/in²)	Elong. (%)	Tensile Strength (tons/in²)	Elong. (%)		
B.S.1490-LM10-W	9·5-11 Mg	22 (18)	12	20 (8)	24 (20)	12	30 (12)	12–15	2–5	Very good	Good
B.S.1490-LM11-WP	4-5 Cu	21 (18)	12	12 (4)	24 (20)	12	20 (9)	18–20	6–8	Fair	Poor
B.S.1490-LM8-WP	3·5-6 Si, 0·3-0·8 Mg	18 (15)	13	½–1	(18)	13	(2)			Very good	Good
B.S.1490-LM22-WP	2·8-3·8 Cu, 4-6 Si				17 (16)	7	9 (8)			Good	Good
D.T.D.5008 "Frontier E"	4·8-5·7 Zn, 0·5-0·7 Mg 0·4-0·6 Cr	(14)		(4)	16 (15)	13*	7 (5)			Very good	Very poor

*0·2% Proof Stress. †References 3-7. ††References 4, 8. **References 4, 8-10. (*Specification Minima are given in brackets*)



A—Without magnesium. B—Containing 0·2 per cent magnesium. C—Containing 0·5 per cent magnesium (Ring castings poured at 100°C. superheat into iron mould).

Fig. 1—Effect of alloy composition on the susceptibility to hot tearing of Al-Cu-Si alloys

tents and also in alloys containing up to 2-2½ per cent silicon. In alloys containing more than 2-2½ per cent silicon the presence of magnesium reduces cracking.

The results of a few tests on the effect of impurities on susceptibility to hot tearing[9] are given in Table II. They show that generally the presence of large quantities of impurities has a beneficial effect, presumably because the impurities increase the proportion of eutectic.

Loss of strength and of pressure tightness caused by porosity. The tensile properties and pressure tightness of poorly fed castings depend on the form and distribution of porosity, and hence on the mode of solidification.[17] In alloys containing only a small proportion of eutectic, porosity occurs as harmful interdendritic channels. As the proportion of eutectic is increased, the cavities become more spherical and isolated, and therefore less harmful. The similarity of the role of eutectic liquid in hot tearing and shrinkage suggests that some correlation should exist between susceptibility to hot tearing and sensitivity to lack of feeding. A correlation is indeed indicated by the results in Table III. Although, therefore, silicon added to improve the hot tearing resistance of the high-strength aluminium-copper alloys reduces their tensile strength, the percentage loss in strength may be much less in poorly fed castings than in test bars.

The effects of gas porosity are similar to those of shrinkage in aluminium-copper alloys; 1 per cent porosity from either source reduces the tensile strength from 23 tons/in^2 to 18 tons/in^2 and elongation from over 10 per cent to about 6 per cent.[3]

Fluidity. Fluidity tests on commercial-purity aluminium, LM6, 4L11 and three alloys containing 2 per cent copper and different silicon contents,[17] have shown that the casting temperature, expressed as degrees superheat above the liquidus, is the main factor controlling fluidity. Differences between the alloys tested were less significant than differences in their other casting characteristics, though for a given superheat a short-freezing-range alloy such as a eutectic flowed further than alloys solidifying in a pasty manner.

Tensile Properties

A distinction has been drawn here between high-commercial-purity and low-purity alloys, the iron content being taken as an indication of purity. High-commercial-purity materials have been regarded as those containing less than 0·25 per cent iron.

Alloys containing less than 0·1 per cent magnesium have been included with those nominally free from this element.

As-Cast Alloys. Scheuer, Williams and Wood[18] investigated the tensile properties of sand cast aluminium-copper-silicon alloys of commercial-purity, in the composition range 0-5 per cent copper, 0-6 per cent silicon. Their results are presented with others[4,5,17,19-26] in Fig. 2 for comparison with those for alloys of different purity and condition.

Tensile strength and 0·1 per cent proof stress are raised and elongation reduced by increasing additions of copper and silicon, copper having a greater influence on tensile properties than silicon. Most of the fall in ductility occurs with a total of copper and silicon contents of about 2 per cent, and the increase in strength with larger alloying additions is slight, presumably because the presence of increasing proportions of brittle intermetallic constituents limits the strength obtainable in the as-cast (but not solution-treated) alloys.

In the region of the aluminium-silicon eutectic (10-13 per cent silicon) the tensile properties are, of course, high owing to modification.

The number of results for high-

TABLE II—EFFECT OF IMPURITIES ON SUSCEPTIBILITY TO HOT TEARING*

Copper Content (%)	Silicon Content (%)	High-Purity Alloy Containing 0·5% Magnesium (length of crack, in. Fig. 1c)	Low-Purity Alloy Containing 0·56% Magnesium 0·65% Manganese, 0·32% Iron (length of crack, in.)
nil	1·13	5	4½
,,	1·65	3½	1½
,,	2·1	2	1
,,	3·1	½	0
0·05	1·13	5	4
0·6		8	9
1·0		8	6
2·0		6	4
4·1		2½	½

**Reference* 9.

TABLE III—CASTING CHARACTERISTICS*

Alloy Type	Resistance to Hot Tearing	Loss of Tensile Strength in Imperfectly Fed Bars		Pressure Tightness in Imperfectly Fed Bars
		% Voids	% Loss of Strength in Imperfectly Fed Bars	
12% Si	No bars cracked	0·7	7	No leaks
3% Cu	No bars cracked	1·8	30	No leaks
5% Si	1/10 restrained bars cracked	1·4	36	Prone to leakage particularly after machining
4½% Cu	No bars cracked	1·2	38	Prone to leakage particularly after machining
7% Cu	No bars cracked	1·7	35	No leaks
13% Cu				

**Reference* 17.

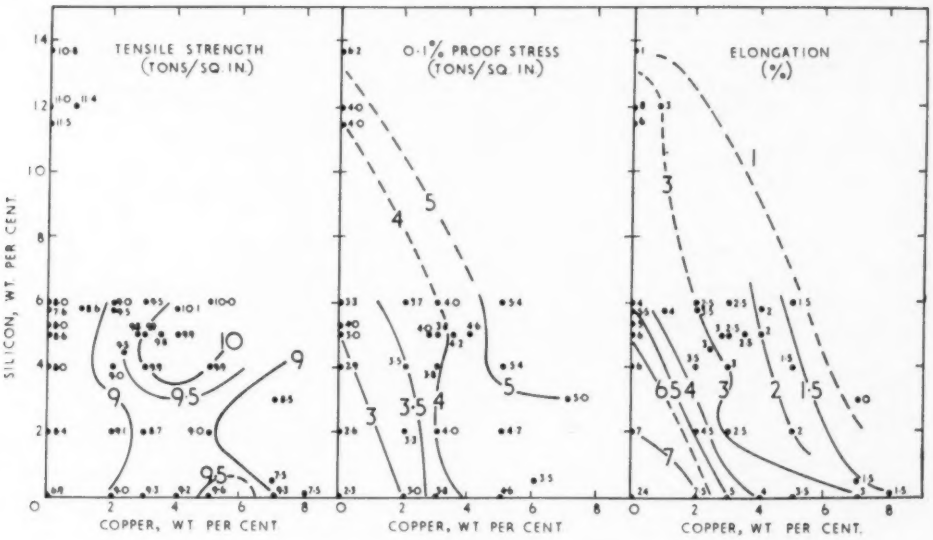


Fig. 2—Tensile properties of low-purity alloys as sand-cast, (British information)

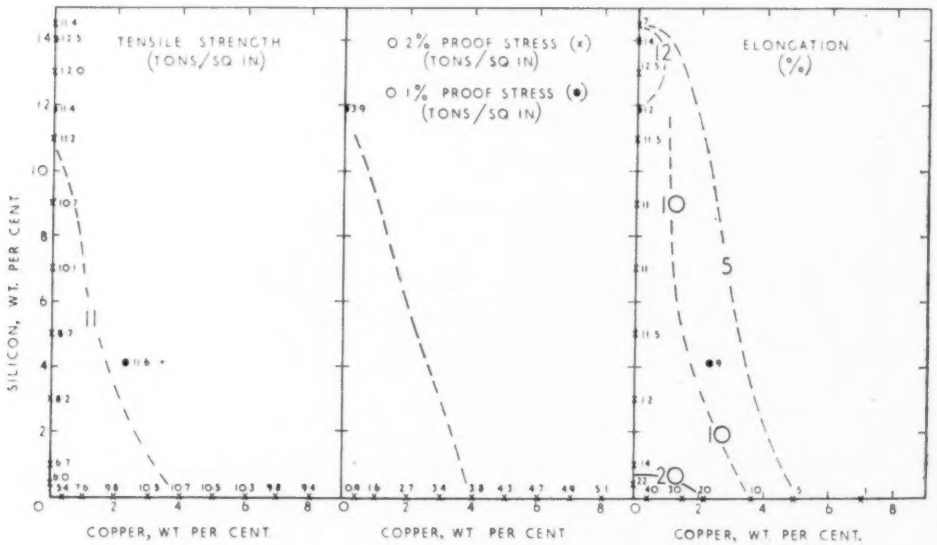

TENSILE STRENGTH (TONS/SQ IN)
0·2% PROOF STRESS (x) (TONS/SQ IN)
0·1% PROOF STRESS (•) (TONS/SQ IN)
ELONGATION (%)
SILICON, WT PER CENT
COPPER, WT PER CENT
COPPER, WT PER CENT
COPPER, WT PER CENT

Fig. 3—Tensile properties of high commercial-purity alloys, as sand-cast (British information (•); American information (x))

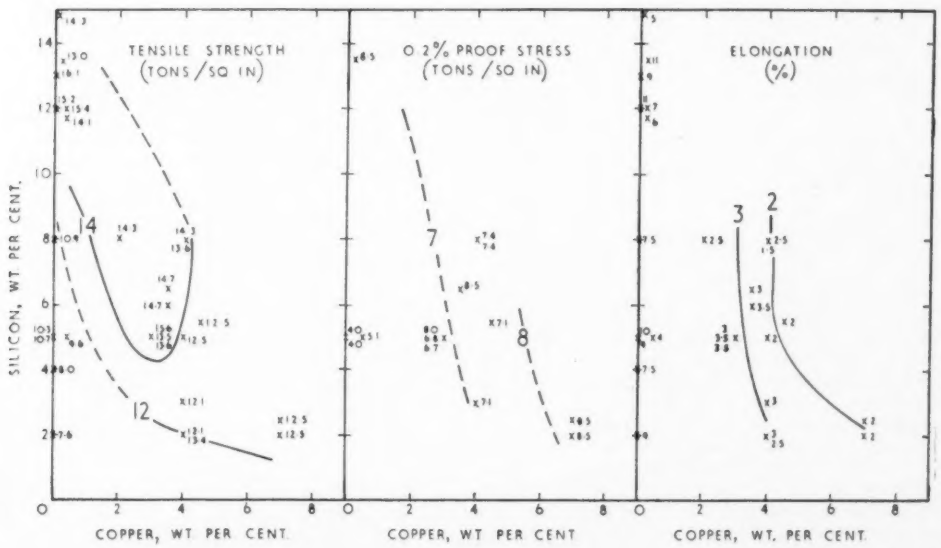


Fig. 4—Tensile properties of low-purity alloys, as chill-cast (American information)

purity as-sand-cast alloys is small, but the results available[17,24,27,28] suggest that the principal difference from the low-purity alloys is the considerably greater elongation (Fig. 3).

Results for commercial - purity materials[28-35] in Fig. 4 show that much higher proof stresses are obtainable in chill cast than in sand cast alloys not heat-treated (the different sources of the information in Figs. 3 and 4 must be taken into consideration), owing to larger concentrations of copper being retained in solution on solidification. Furthermore, the increase in tensile strength with copper and silicon contents is less restricted by the intermetallic constituents present.

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(To be concluded)

Readers' Digest

CONTINUOUS CASTING

"Handbuch des Stranggieszens" (*"Handbook of Continuous Casting"*). *By Dr. Erhard Herrmann. Published by Aluminium-Verlag G.m.b.H., Düsseldorf. Pp. xii + 916. Price DM. 225·0.*

CONTINUOUS casting is like an iceberg: there is very much more to it than meets the eye. To Dr. Herrmann, the head of the Patents Department of the Aluminium-Industrie-Aktien-Gesellschaft, the full bulk of the subject must for many years have loomed truly large from the files of his department. It is, therefore, all the more to his credit that, in spite of the only too apparent magnitude and intractability of this bulk of information he should have decided to explore, sort out, and finally to present it in the volume under review.

The book is divided into three main sections. The first of these gives details of patented continuous casting processes, machines, ancillary equipment, operations, etc., without particular reference to specific metals. Within this section, the subject matter is subdivided according to the type of casting moulds — moving and fixed — and according to the component operations —the supplying of the molten metal, cooling, lubrication, agitating of the molten metal in the mould, subsequent treatment, etc.—and the corresponding equipment and devices.

The second section of the book surveys the continuous casting of specific metals: aluminium and its alloys, magnesium and its alloys, copper and copper alloys, other common non-ferrous metals, iron and steel, and the "refractory" metals such as titanium and zirconium. In each case there are surveyed the general literature and the specific patents (with cross-references to any relevant basic patents dealt with in the first section), the various industrial processes are described and illustrated by photographs of the installations, and accounts are also given of any more fundamental work relating to continuous casting of metal, e.g. research and theories concerning the solidification mechanism, segregation, microstructure, internal stresses, and similar topics.

The third section, which incidentally runs to nearly 150 pages, contains tables of patents referred to in the text, tables of patents arranged by countries (19 of them), a literature reference index arranged by language and journals, an author index, German-English-French glossaries of terms relating to continuous casting, and subject indexes, also in German, English and French.

So much for the scope of the contents. The volume of the contents may be gauged from the statement that mention is made of some 3,300 patents and 327 literature references, and that there are over 2,000 illustrations.

As a source of factual information and as food for thought, all those even remotely interested in continuous casting certainly owe it to themselves to acquire a copy of this work—which, one may hope, will be added to by the publication of a supplement as and when necessary; this book is too valuable to be left to become out-of-date.

HARDENING

"Harterei—Technische Mitteilungen." (Part III). *Edited by Prof. Dr.-Ing. P. Riebensahm. Published by Deutschen Verlags-Anstalt G.m.b.H., Stuttgart. Pp. 35. Price DM. 3·90.*

THIS work on the hardening of steel, is a short digest consisting of 35 pages on hardening technique. The work consists of two articles: the first by Alois Legat, on "Homogenizing of Austenite," and the second, by Karl Wagner, on "Factors Influencing the Heat-Treatment of High Speed Steels."

The interesting data in the first article is compiled from observations and qualifications of microhardness testing of steels, and it emphasizes the sluggishness of certain steels to become homogenized unless carefully selected time-temperature factors are adhered to; tests were made on steels homogenized at various temperatures and/or at constant temperatures with varying time observations. This work is a valuable asset to the second article by Wagner, who introduces some excellent facts on the effect of varying time and temperature on heat-treatment efficiencies. He offers the reader some valuable curves giving hardnesses from the Vickers Pyramid Diamond testing machine and Rockwell C hardnesses in relation to heating times before hardening and for tempering to obtain secondary hardness-ageing-phenomena. This little booklet is a concise communication from two authorities who have made accurate observations of time-temperature heat-treatment of high speed steels.

D. Ll.

PRODUCTION OF LIGHT METAL SEMIS AT FINSPONG

AB Svenska Metallverken

By L. TILLBERG

(*Concluded from* METAL INDUSTRY, 16 *October* 1959)

FINSPONG may, perhaps, be regarded as typical of the many little Swedish towns which grew up where a small stream offered water power and which have gradually developed into important industrial centres. To-day, about 1,900 of the 14,000 inhabitants are employed by Metallverken's Finspong Works, and a company belonging to the ASEA group employs about the same number of people.

Production at the Finspong works is dominated by light metal "semis," which include sheet, strip, foil, bars and sections. With the exception of copper tubing used in the building industry, which is made at Granefors, the company's production of tubes is centralized at Finspong. There is also a rolling mill for flat copper alloy products with special quality requirements, such as radiator strip. The annual output at the Finspong Works totals nearly 30,000 tons.

In the spring of 1959, a new re-melt shop for aluminium was completed and produces, in conjunction with the old shop, about 30,000 tons of light alloy ingots per year. In designing the new buildings, light metals have been used wherever this could be economically justified. Thus, the walls are clad with corrugated sheet and the insulated aluminium roof is supported by light alloy beams. The three new 500 kW low-frequency channel induction furnaces were delivered by the company's furnace-building subsidiary. Each furnace is equipped with two transformer units which have been made easily detachable to permit quick changes. The furnaces, which are tilted by means of hydraulic cylinders, are used for melting as well as for casting, and each is equipped with a mechanically-operating casting machine. D.C. drive permits excellent facilities for adjusting the pouring rate, and the furnace cavity is designed to keep the surface area constant during the pour. The available capacity is 13,000 lb. and total capacity 20,000 lb. for each furnace. Slabs with a cross section up to 40 in. × 8 in., weighing two tons, can be cast, and billet sizes vary between 5 in. and 10 in. The old shop has 17 furnaces for total charge weights between 500 and 9,000 lb. Saws, scalping machines and a scrap baling press complete the equipment in the re-melt shops, which also have a spectrograph for alloy control.

The aluminium rolling mills produce about 17.000 tons a year of sheet, strip, foil stock and circles, including a substantial amount of corrugated sheet. The 2-ton slabs are processed in equipment including a break-down mill, a tandem hot-rolling mill and a tandem cold mill, which, like several smaller mills and most of the furnaces, have been built within the Metallverken group.

The slabs are homogenized and brought to rolling temperature in four electrically-heated soaking pits, each holding six 2-ton slabs. The temperature is automatically controlled within narrow limits and can be varied between 400 and 600°C. A special crane is used to charge the pits and take out slabs ready for rolling.

The break-down mill is a reversing four-high driven by a 2,400 h.p. D.C. motor with a speed range of 0-500 r.p.m. The rolls are balanced hydraulically and are carried in SKF roller bearings. Work rolls have a dia. of 28 in. and back-up rolls 43 in. Roll face is 80 in. The slabs are rolled down from 8 in. to strip just over $\frac{3}{8}$ in. thick in 11 to 19 passes, depending on the alloy. A roller table then transfers the strip to the non-reversing tandem hot mill, where it is reduced to a thickness of 0·11 in. without re-heating.

This mill consists of two four-high stands with about 18 in. work roll dia., 43 in. back-up roll dia., and 65 in. roll face. Each stand is driven by two 1,500 h.p. D.C. motors and the maximum speed in the second stand is 500 ft/min. The chocks are held tightly together by means of heavy bolts, and roll gap adjustment is done by turning eccentric sleeves embracing the top back-up roll bearings. Normally, the strip is coiled after rolling, but there are provisions for taking it past the coiler and cutting it in suitable lengths. The coiler has a collapsible arbor and is equipped with a belt wrapper and devices to remove the coils and carry them away from the

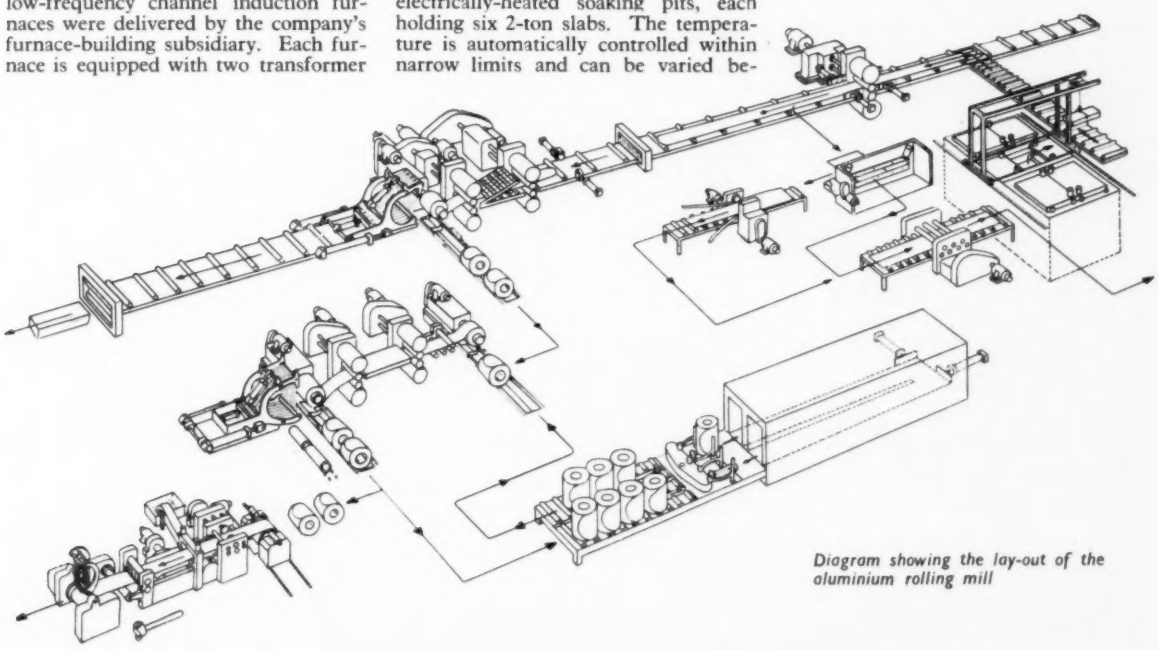
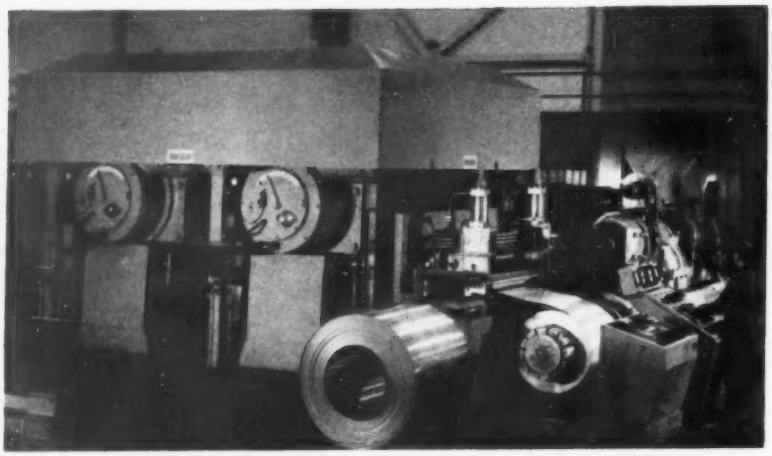


Diagram showing the lay-out of the aluminium rolling mill



Tandem 4-high cold rolling mill for aluminium strip

mill. The mill is handled by a crew of three.

The tandem cold mill is built along the same lines as the hot mill, but each stand is driven by one 1,500 h.p. D.C. motor. The mill is mainly used for reducing the hot rolled strip from 0·11 in. to 0·016 in. in two runs without intermediate annealing. Finishing speed is 1,000 ft/min. The mill is built for a maximum strip width of 48 in. and the work roll dia. is 15 in. Although the mill is non-reversing the rolls can be run slowly backwards in case of jam. At the entry side, a bridle feeds the strip to the first stand, and the take-off reel can be slid sideways for centring the strip. For fire protection, a fully-automatic carbon dioxide extinguisher system is provided.

The motor generator sets for the hot and cold mills and the drive motors for the hot mill are placed in a machine room which is separated from the rolling mill by an airtight aluminium wall. The two mills have identical drive motors, and further, the six D.C. generators in the two motor generator sets are identical with the mill motors. This arrangement considerably simplifies repairs and reduces the stock of spares.

After cold rolling, the strip is slit and edge-trimmed in a modern Achenbach slitting line and then annealed in a pusher type furnace and cut to sheet in a Halden machine. Further cold rolling is done in several smaller mills, of which one is a tandem four-high with a maximum finishing speed of 1,600 ft/min. This mill is used for strip up to 20 in. wide, starting at 0·02 in. and rolling down to 0·002 in. Motor power for the first stand is 160 h.p. and for the second stand 270 h.p. The rolls can be accelerated from threading speed to maximum in 2 sec. When rolling unalloyed aluminium, the gauge can be automatically controlled within certain limits by means of a gauge meter measuring the non-inductive resistance in the strip. The impulses from the gauge meter are amplified and fed back to the motor speed controls, varying the strip tension between the two stands.

The equipment in the aluminium rolling mills further includes an old two-high hot rolling mill for slabs weighing up to 250 lb., a four-high Sack mill which was formerly used for strip rolling and which has now been equipped for sheet rolling, numerous annealing furnaces, and stamping machines for making circles and slugs for impact extrusion.

Aluminium foil is made in a special department equipped with light two-high and three-high rolling mills. The most common gauge is 0·00035 in. and the foil is produced from 0·02 in. or 0·03 in. strip using a reduction of 50 per cent per pass. The present maximum width is 28 in. Foil conversion includes laminating, embossing, lacquer coating and flexographic printing in up to four colours, and about 80 per cent of the output is given such treatment. Production in 1958 amounted to nearly 900 tons (aluminium weight), which is not sufficient to cover the demands of the Swedish market. It has, therefore, been decided to expand this manufacture, and as space is very limited at Finspong the production of foil will be moved to Skultuna, where new buildings are being erected. At the same time, the equipment will be modernized and a new rolling mill and other machinery, capable of handling foil in widths up to 45 in., have been ordered.

In the extrusion department, four presses with capacities ranging from 1,000 to 3,500 tons produce sections, bars, rod, wire, strip and tube shells in about 20 different light alloys. The 3,500-ton press is a modern self-contained oil-hydraulic Loewy press fitted with some unique handling equipment. Billets weighing up to 425 lb. are heated to the extruding temperature in two Magnethermic low-frequency induction heaters and are then automatically transported to the press and charged together with the dummy block. The ram speed can be set at a pre-determined figure and can be continuously varied from 0 to 1 in/sec. The run-out table is made in three parts, each consisting of two parallel endless chains carrying blocks of graphite between them. The speed of the first part is set to correspond with that of the extrusion being produced. A flying saw, controlled by a photo-electric cell, cuts the extrusion in pre-determined lengths, and the second and third parts of the run-out table, which are run at a higher speed, carry away the cut lengths. At the end of the table, a limit switch actuates a number of pushers which move the extrusion on to a walking beam-type cooling bed.

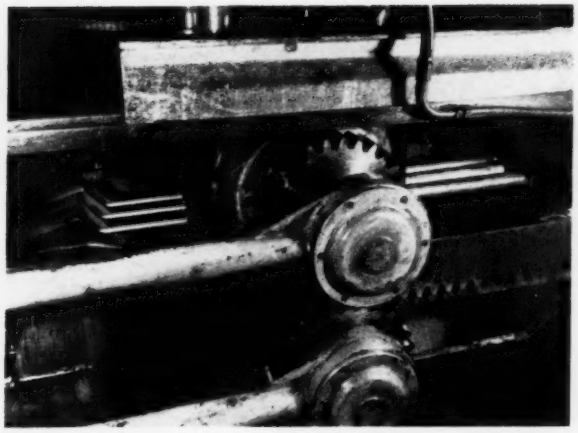
In this press, extrusions with a circumscribed diameter up to 12 in. can be produced. The largest container is 15 in. in diameter. The press is served by a crew of four, including billet saw and furnace operators.

Two older presses, a 2,200 ton piercing press made by Hydraulik and a 1,000 ton Fielding and Platt press are fed from a common accumulator and pump plant. Both presses are served by low-frequency induction billet heaters. A very old 1,200-ton press, which is placed in the old parts of the works, is used for producing small sections for the aircraft industry.

Rod and sections in lengths up to 40 ft. are solution heat-treated in a vertical electric furnace. Two quenching tanks hang from a rotary platform. This arrangement allows the tanks to be moved aside so that the furnace can be charged with dry sections. In addition, heat-treatment and ageing are done in a number of horizontal furnaces. A 250-ton stretcher built by Loewy and a number of drawbenches, straightening machines, etc., complete the equipment.

The tube mill produces about 8,000 tons a year of seamless tubing and hollow sections in all sizes from capillary up to a diameter of over 20 in. Brass tube shells up to about 4 in. are produced in vertical extrusion presses. The largest, a 1,500-ton Serck-type press, is provided with extensive handling equipment. Billets are sawn and drilled in a semi-automatic plant and transported to a low-frequency induction heater which is charged automatically. A special device inserts the heated billet into the container, and the extruded shell is received in a vertical channel, which is tilted to a horizontal position after the discard has been cut off. The shell is then pushed out of the channel and a roller table takes it to the cooling bed. The whole process is handled by a crew of three. This press is mainly used for producing condenser alloy shells $2\frac{1}{2}$ in. × $\frac{7}{16}$ in. in about 15 ft. lengths, at a rate of roughly one per minute.

Smaller brass tube shells are extruded in a 1,200-ton Hydraulik and a 40 year old mechanical press. Brass and copper shells over 4 in. diameter are produced in an Evans-type piercing mill and copper shells under 4 in. are pierced in a Mannesmann mill. The extrusion process is normally not



Above : The die roll carriage of the tube reducing machine

Left : 3,500 ton Loewy extrusion press with run-out table and flying saw

employed here for producing copper shells. The piercing mills are relatively old, but modern handling devices have been added. Labour required to operate the Evans mill amounts to three men and two are needed for the Mannesmann, including operators of the oil-heated furnaces.

Further processing is done in drawbenches and tube reducers. For the larger tubes, there is a 200-ton hydraulic bench and three chain driven drawbenches with capacities between 30 and 50 tons. A semi-automatic 25-ton Aetna Standard single bench is mainly used for reducing pierced copper shells, and there is also a similar machine with a capacity of 12 tons. Smaller tubes are drawn in benches with capacities between one and six tons.

A tube reducing machine built by the company is mainly used for processing 2½ in. condenser alloy shells. Three such shells are reduced simultaneously to 1 in. outside diameter, the total area reduction being about 80 per cent. The machine is operated by one man and the output is about 1,600 lb/hr. Three smaller reducers of conventional design built around 1930 are still in use.

Batch-type furnaces, as well as a continuous conveyor furnace, are used for intermediate annealing. The auxiliary equipment includes both hydraulic and mechanical pointing machines, roller straighteners and reeling machines, tanks for lubricants in which tubes are dipped before drawing (the drawbenches are not equipped with recirculating lubricating systems), and pickling and rinsing baths. Leak tests are done hydrostatically with pressures from 0 to 2,000 lb/in^2, one of the machines testing five tubes at a time. Condenser tubes are 100 per cent tested, with flaw detectors of the induction type.

Responsibility for the quality of the goods lies with the departments which produce them, and to supervise and control the quality of their products, the shops use testing equipment for checking grain size, mechanical strength, dimensional accuracy, and general finish.

There is, however, also a special quality control department for testing material for which a certificate is required. This department also makes spot checks of all products made and is responsible for testing the raw material delivered to the works. Systematic analysis of control data with the aid of statistical methods is considered an important part of the quality control department's job.

Routine control work is done by the laboratory, where about 20,000 chemical and 250,000 spectrographical analyses are made annually. All light alloys are analyzed in the A.R.L. quantometer, and a Philips X-ray fluorescence apparatus for copper alloy analyses is being installed.

The research done at the Finspong laboratory is concentrated upon aluminium and its alloys. The section dealing with surface treatment has equipment for studying anodizing, chemical surface treatment and lacquering. The corrosion resistance of different alloys is tested in a new corrosion laboratory, and there are about 10 stations in various parts of the country where test pieces are exposed to wind and weather. The welding section mainly devotes its time to studying the metallurgy of welding.

Granefors Works

The plant at Granefors in the south of Sweden specializes in the production of standard gauge copper piping, used in the building industry. With a total work force of 140, the plant produces annually nearly 5,000 tons of copper tubes in diameters up to 2½ in. Starting material is 3 in. billets, which are pierced in a Mannesmann mill similar to the one in Finspong. The drawing equipment includes two Arboga benches with capacities of 25 and 17 tons respectively, a 12 ton Aetna Standard triple bench drawing tubes to lengths up to 70 ft., and several smaller benches. Bull blocks are also used. A continuous roller hearth furnace is capable of bright annealing a maximum of two tons of copper tubes per hour. The inert atmosphere consists of nitrogen with a small content of hydrogen, produced by burning cracked ammonia.

Skultuna Works

At Skultuna, some of the "semis" made in Västerås and Finspong are converted to products in various stages of finish. To the public, Skultuna is best known for its production of cooking utensils, but even though some 300,000 pots and pans are made each year, these are only a small part of the total output. A large sheet-working shop produces vats and tanks to order in copper and aluminium, and standard products such as transport containers are also made. In another department, numerous details of copper and aluminium alloys such as nuts and screws are produced in automatic screw machines.

During the last few years, the technique of welding aluminium alloys has developed very rapidly and research carried out at Skultuna has put the welding department well forward in this field.

Atomic Progress

Ductility of Beryllium

AN experimental project, the advanced gas-cooled reactor (A.G.R.), aims at reducing capital costs and improving fuel utilization. In A.G.R., it is intended to use beryllium for canning the fuel and for structural purposes. Beryllium possesses attractive nuclear and high temperature properties, but to date has only found limited application for moderators and reflectors. Although many technological problems associated with the production of beryllium have been successfully overcome, there are a number of formidable development problems still to be resolved. One of the most important of these is the relative lack of ductility of beryllium.

Studies of purity and or crystallographic features may lead to improved ductility and the influence of these factors will be discussed in this article.

Purity

The work of Sloman[1] is probably the first study of the brittleness of beryllium in which purity was suggested to be the cause. In this work, brittleness was attributed to microscopically-visible intergranular oxide. Beryllium free from visible intergranular oxide exhibited brittleness and the theory was discredited. However, recent, and as yet unpublished, work by Scott and Wilman is quoted by Ellis[2] as lending some support to this suggestion, since these workers have detected intergranular oxide films in cast and extruded cast beryllium using an electron diffraction technique. Kaufmann[3] considers the negligible solid solubility of impurities such as Al, Si, C, O_2 and N_2 implies that the metal cannot be solution hardened. Ellis[2] and his co-workers at A.W.R.E., on the other hand, feel that the brittleness of currently-available beryllium is attributable to interstitial impurity atoms which cause lattice distortion and inhibit slip and possibly twinning.

In 1945, Raynor[4] suggested that the brittleness of beryllium was due to the low crystallographic axial ratio (1·567), but titanium and zirconium have similar axial ratios (1·587 and 1·589 respectively) and high purity samples have been shown to have high ductility. Pugh[5] suggests that the inherent ductility of beryllium is low due to the low bulk modulus and the high shear modulus of the metal.

Thus controversy exists as to whether beryllium is inherently brittle or whether brittleness is due to lattice embrittlement by impurity atoms or intergranular oxide films, and this situation can be resolved only by the preparation of high purity beryllium and the determination of its properties in single crystal and polycrystalline forms. Attempts to achieve this using pure beryllium produced by the Van Arkel technique, by zone melting and vacuum distillation have so far been unsuccessful either due to incomplete removal of metallic impurities or because suitable test specimens could not be obtained.

Ellis[2] indicates three factors in support of embrittlement of beryllium by impurity atoms. First, beryllium containing 0·2 per cent oxygen has been found to be brittle and the oxygen content could not be detected microscopically. Similar oxygen additions in titanium and zirconium markedly reduce ductility and Ellis suggests the effect may be greater in beryllium, where the closest distance between atoms is least and lattice distortion therefore greatest. Second, he suggests that, as in titanium, the critical resolved shear stress for slip on prismatic planes is affected by interstitial impurities and that prismatic slip is favoured by increasing purity. Third, a series of features, including the decrease in ductility between 400°C-600°C. in the twin peak ductility curve, strain and quench ageing effects, the sub-melting point thermal arrest obtained in relatively high purity metal and suggestions of allotropy, could be explained on the basis of a soluble impurity content. More marked improvement in ductility is predicted for beryllium than is obtained for titanium and zirconium at the possible expense of strength and grain size. These arguments are all based on analogy with the metals titanium and zirconium, which Ellis considers less susceptible to damage than beryllium. Whilst Ellis is confident that methods will be found of preparing very high purity beryllium on an experimental scale, he notes that difficulties may arise from the need to consolidate the metal in order to evaluate its properties. A further difficulty is the lack of reliable analytical techniques for low levels of impurities, particularly oxygen. The problems involved make it unlikely that methods of producing high purity beryllium on a production scale will be evolved for many years.

Crystallographic Features

For this reason, alternative methods of overcoming the lack of ductility have to be sought and studies of the modes of deformation and development of preferred orientation offer some degree of success. In beryllium at room temperature, slip occurs only on the basal and $(10\bar{1}0)$ prismatic planes, and twinning only on the $(10\bar{1}2)$ planes. In randomly-oriented polycrystalline material basal slip predominates and usually leads to kink formation and fracture on basal or $(11\bar{2}0)$ planes. Increasing temperature reduces the resolved shear stress for prismatic slip and slightly increases that for basal slip. These changes are believed to lead to the rapid increase in ductility with temperature up to 400°C. Above 600°C. the rise in ductility is attributed to the incidence of pyramidal slip and, above 800°C., intergranular cavitation leads to reduced ductility. The minimum in ductility at about 600°C. has not been explained, although Ellis[2] suggests precipitation hardening may be responsible.

Beryllium rod extruded from powder exhibits a $(10\bar{1}0)$ fibre texture which increases in perfection with increasing extrusion ratio at 1070°C.[6] For extrusion ratios below 15:1, the ductility increases rapidly with extrusion ratio to between 10-20 per cent in the extrusion direction, above 15:1 reduction there is little effect. Beryllium sheet fabricated from extruded flats rolled perpendicular to the extrusion direction has basal planes parallel to the extrusion direction and inclined at about 15° from the normal to the sheet. This orientation is most strongly developed at a reduction ratio of 8:1. In mechanical tests to determine strength and ductility in both longitudinal and transverse directions as a function of reduction ratio it was found[6] that maxima in both properties occur at a reduction ratio of 8:1 with average values of ductility in the plane of the sheet of 40 per cent. This material is termed "two-way ductile" sheet. Williams and Hill[7] report that extruded beryllium tubes develop textures which are little affected by the working temperature but vary with extrusion ratio. At extrusion ratios of less than 12:1 the basal planes tend to align themselves parallel to the surface of the tube and at greater reduction ratios the basal planes still lie parallel to the extrusion direction, but tend to lie at right angles to the circumference of the tube. A prism plane fibre texture is present in all tubes. The low reduction tubes have a similar texture to two-way ductile sheet. This sheet cannot neck down in the plane of the sheet, hence, in a tube, circumferential hoop stresses will increase the diameter only if the tube can shorten, and similarly the length can only increase under a tensile stress if the diameter decreases. The high reduction tube can be expected to yield in tension longitudinally with a decrease in wall thickness but exhibit virtually no ductility under tensile hoop stresses. The behaviour of such tubes under the complex multi-axial stresses which may develop in fuel elements during service cannot be predicted and is being determined experimentally. Tubes machined from extruded rod would probably be

(*Continued on page 246*)

ELECTRIC BATCH FURNACE INSTALLATION AT PORT TENNANT

Heat-Treatment of Aluminium Wire

ALTHOUGH continuous or semi-continuous furnaces are used for many applications, the batch method has generally been found to be quite satisfactory for the heat-treatment of aluminium in its various phases of production. At the works of Aluminium Wire and Cable Company Limited, at Port Tennant, Swansea, three electric batch furnaces, of the twin chamber type, built and designed by G.W.B. Furnaces Ltd., of Dudley, Worcs., are used for this work.

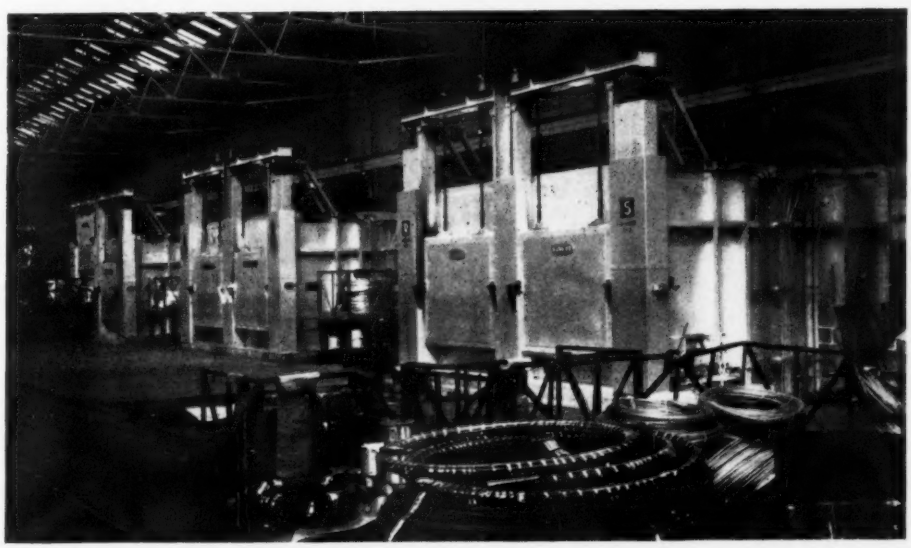
Aluminium Wire and Cable Company Limited was formed in 1946 to specialize in the production of aluminium wire and stranded conductor for overhead power transmission and distribution lines. The company was formed as a joint project resulting from the co-operation of several large companies who pooled their resources to provide maximum facilities for research and development. Included in the present range of products are hot rolled rod; solid and stranded conductors; round wire in coils, on reels, or in straight lengths; wire in rectangular and other sections; rivet wire; nail wire; flattened wire, etc. Materials processed comprise various grades of aluminium, from commercial purity to super purity, and a wide range of aluminium alloys, delivered to the works in the form of wirebars, 4 in. square and 9 ft. long.

Wire Production

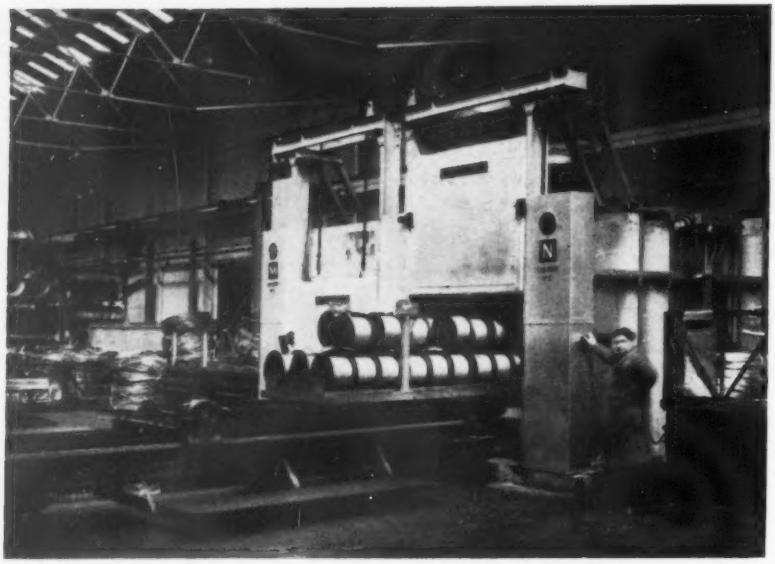
A high-speed, semi-continuous rod mill progressively reduces the wirebars pre-heated in electric resistance furnaces, by passing them between a series of rotating grooved rolls until the required size of round rod—usually $\frac{1}{8}$ in. diameter — is obtained. The potential output of this mill is 30,000 tons/year. Wire drawing machines, including heavy duty single die machines, multi-die machines for drawing intermediate sizes, and multi-die fine wire machines, draw the wire to the finished sizes, the normal range being from $\frac{1}{8}$ in. diameter down to 0·0052 in. diameter. Intermediate and final annealing and heat-treatment, essential processes in the production of many grades of aluminium and aluminium alloy wire, are carried out in the G.W.B. furnaces. The various purities of aluminium and certain aluminium alloys derive their strength from work hardening during drawing and may be softened by closely controlled annealing at temperatures of the order of 380°C. Other alloys derive their strength from heat-treatment after drawing. Such alloys fall into two categories, the first of which harden at room temperature after solution treatment and those which require a further heat-treatment, known as precipitation treatment, to attain maximum strength. The temperature of the solution heat-treatment varies according to the composition of the alloy being processed, but this is generally in the region of 500°C. A feature of this process is the rapid quench that is required immediately the material is withdrawn from the furnace, so as to fix the alloying elements which have been brought into solution by the heat-treatment. Care is taken to ensure an even, speedy quenching to avoid the distortion and uneven physical characteristics which would result in the metal in the event of uneven quenching. Precipitation hardening is normally carried out within the range 170°-190°C. For this low temperature heat-treatment, the power input to the furnace is reduced from the maximum available by means of Delta/Star switching, which has the effect of reducing the power to one-third. This power reduction when operating at the lower temperature range, during which less power is required, assists in reducing wear on the furnace contactors.

Furnace Line

The three G.W.B. furnaces are installed in a heat-treatment line and are served by a single Gibbons-van Marle charging machine which traverses along a track running the length of the treatment line. This machine is all electric and has two charging arms with a run-out of 14 ft. 3 in. and is capable of handling a load of 1½ tons. The maximum discharge speed is 200 ft/min. with an average speed of 100 ft/min. and the lifting motion occupies 10 sec. This arrangement allows a speedy quench when solution treatment is being carried out. The traversing movement of the charging machine is approximately 100 ft/min. Between the furnaces and in line with them is a series of charge tables, the tops of which are grooved to accommodate the arms of the charging machine. The overhead crane is only used for placing the charge skips on the loading tables initially and removing the heat-treated charge from them for transfer to another part of the works, and for placing the charge into and removing it from the quench tank when solution heat-treatment is being carried out. There are two quench tanks sunk into the floor, on the inside of the charging



Complete heat-treatment line of three G.W.B. twin chamber furnaces. A load of coils is being withdrawn from the end furnace, and other loads awaiting treatment are shown on the loading tables between the furnaces



Reels of wire on a special charge carrier being unloaded from one of the furnaces. Charge skips for coils are shown on the loading tables on each side of the furnace

machine track, in front of the first and third furnaces.

The first two G.W.B. furnaces were installed at the end of 1949 and to cope with increased production a third was subsequently installed. The heating chambers are 12 ft. 0 in. long by 4 ft. 6 in. wide by 3 ft. 0 in. usable height, and the walls are lined with heavy aluminized mild steel plate, while specially moulded refractory bricks form the roof arches. These linings are backed by insulating bricks and semi-rigid slab type insulation to reduce heat losses to a minimum. Bonded refractory and semi-refractory brickwork lines the heat-resisting steel hearth tracks which accommodate the arms of the charging machine. Three rows of heat-resisting charge supports extend the full length of each chamber and are provided with holes designed to ensure efficient air circulation under and vertically through the aluminium coils.

The heating chambers are rated at 144 kW each, in two independent automatically-controlled zones. This rating is reducible by Delta/Star switching, working in conjunction with temperature controllers, for use during soaking periods or for low temperature treatments. Each zone has its own forced air circulation system provided by air circulation fans directing an air current through heating elements which are suspended from the furnace roof, and are of nickel-chromium strip in sinuous form arranged edge-on to the air flow. Aluminized mild steel baffle plates separate the heating elements from the chamber, thus preventing direct radiation on to the sides and top of the charge; these baffles are designed to direct the high speed air flow through the elements, under and up through the charge.

Each of the multi-blade high velocity fan units fitted in the roof is mounted on a high tensile shaft carried upon heavy ball and roller bearings. A heat-dissipating rotor fitted directly above the furnace top plate ensures permissible bearing temperatures, and the shaft is driven through Vee ropes by an independent, totally-enclosed motor mounted as a unit on the top beams of the furnace casing.

Each chamber has an independent steel encased, fully insulated and balanced door; the doors are driven automatically by an electric motor, and operation is by push button control from the furnace front. To cut out heat losses the doors are arranged to clamp automatically against the front-plate when closed.

The number of alloys requiring different treatments, and the variety of heat-treatments carried out, necessitates a high degree of temperature control for each furnace. This is provided automatically by a G.W.B. totally-enclosed instrument cubicle housing four potentiometric non-indicating controllers, two potentiometric 2-point recorders, which enable a visual check to be made at any time during the process cycle, and automatic time switches. The necessary switchgear is contained in another G.W.B. cubicle housing the four furnace contactors, Delta/Star fan motor starting contactors, etc., and the rating reduction switches. Safety contacts are fitted to the recorders so that the main electric supply is cut off automatically in the event of accidental overheating in any zone.

Lighting Arc Welding Torches

POSITIVE arc starting for Heliarc (inert-gas tungsten-arc) spot welding or cutting whenever required is a great advantage, especially in mechanized installations where torches must be fired according to a predetermined schedule.

Previously, the use of high frequency current has been the accepted method of arc starting for Heliarc spot welding, but this frequently gives rise to erratic firing from a cold electrode.

A system called "Pilot-Arc" starting that eliminates all high-frequency interference problems and avoids the contamination problems of retract starting has been introduced by Linde Department, Union Carbide International Company. Electrode life is increased by a factor of four over high-frequency starting, and process reliability is greatly increased.

In this system, a ball of incandescent gas remains within the cup so that the arc is always ready to fire as soon as potential is applied between torch and workpiece. The current is adjusted to about 5 amp, and is maintained between electrode and water-cooled nozzle. A small quantity of shielding gas flows continuously and protects the electrode while the pilot is on.

When the torch is brought into welding position against the work, and the trigger pulled, the "Pilot-Arc" provides a path for the main welding current, which instantaneously flashes across to the work and makes the spot weld.

In operation, the system is very simple. The operator lights his torch at the start of the work shift, using a tungsten rod to make contact between the tungsten electrode and the nozzle. The torch stays lit throughout the work day.

Atomic Progress

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more ductile where the basal planes are randomly-oriented relative to the circumference of the tube although aligned parallel to the extrusion direction.

Considerable progress has been made in the development of ductile beryllium. In fuel element applications tensile stressing appears undesirable and, in addition, in fabricating fuel elements (e.g. can sealing) care is required to avoid destroying locally specially-developed controlled orientations, and the fuel element designer must exercise his skill to work within these limitations.

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Industrial News *Home and Overseas*

New Foundry Division

News from **Efco Limited** is to the effect that they have formed a new division to extend their interests in the foundry trade, to whom they already supply a wide range of equipment for drying cores and moulds, and for the heat-treating of castings. New Efco products will include gravity die-casting machines, portable electric mould driers, shell moulding and shell closing machines.

A 10-Year Club Dinner

An interesting event was held recently at the Wimbledon Hill Hotel, when members of the **Foxboro-Yoxall Limited** 10-Year Service Club attended their 11th annual dinner. One hundred and seventeen long-service members of the staff attended the function, which coincided with the company's 25th anniversary.

Tube Bending Machines

It has been announced by **Chamberlain Industries Ltd.** that it has accepted the sole distributorship for Great Britain and the Commonwealth of the Swedish manufactured Heber motorized tube bending machines, for cold bending thin-walled tubes and sections to small radii.

These can be offered in two sizes, the model RBM-40 being suitable for steel tubes up to $1\frac{1}{2}$ in. diameter times $\frac{1}{16}$ in. thick and brass 2 in. diameter times $\frac{1}{4}$ in. thick, and the RBM-60 for steel tubes up to $2\frac{3}{4}$ in. diameter times $\frac{1}{16}$ in. thick, and brass $2\frac{1}{4}$ in. diameter times $\frac{1}{4}$ in. thick.

The machines are equipped with a quick-acting locking device for clamping the pipe and, since this operation can be carried out very quickly with one movement of the hands while the jaw also swings clear, leaving room for the removal of the ready-bent tube, accurate and efficient bending is ensured. The design allows for simple and quick changing of tools, which are normally supplied to suit a radius equal 3 by D.

Norwegian Ore for Germany

It is reported from Oslo that the affiliated Norwegian mining concern, Bleikvassli Gruber and Mofjellet Gruber, producers of zinc, lead and copper concentrates, have sold in advance their scheduled 1960 output of these three concentrates to buyers in West Germany, according to Mr. Holger Fangel, managing director of the two concerns. Production next year is expected to reach between 12,000 and 15,000 tons of zinc concentrate, 4,000 to 5,000 tons of lead concentrate, and some 1,000 tons of copper concentrate.

The two companies also produce sulphur pyrite as a by-product. Mr. Fangel stated that demand for this remained weak, and to provide an outlet for it his companies might build a sulphuric acid factory. Plans are now being considered for a plant with an annual output capacity of about 40,000 tons of acid.

Italian Copper

According to the Central Statistical Office in Rome, Italian imports of crude copper for smelting and refining in the first seven months of this year amounted to 2,131·1 metric tons, valued at 843,688,000 lire. Imports of refined copper in slabs, ingots, shot and powder totalled 60,887·2 metric tons, valued at 23,739,103,000 lire, of which 10,588·5 tons, valued at 4,243,008,000 lire were imported temporarily.

Main suppliers were the Belgian Congo with 15,410·7 tons, Rhodesia and Nyasaland with 10,350·1 tons, Chile with 11,245, the United States with 11,340 tons, Britain with 5,856·5 tons, Belgium-Luxembourg with 1,798·2 tons, and South Africa with 2,282·4 tons. Exports of refined copper in slabs, ingots, shot and powder amounted to 63·9 metric tons, valued at 24,224,000 lire during the first seven months of this year. Britain received 31·9 metric tons.

Danish Lead and Zinc

Unfavourable ice conditions in Greenland waters and marketing difficulties as a result of low world market prices have hampered sales of the 1959 production of lead and zinc concentrates from the Nordic Mining Company's plant at Mestersvig, in Greenland, according to a company report. Unsold stocks of these concentrates from 1959 production total 8,000 tons, the report added.

Future prospects were not bright, according to Mr. Viggo Brinch, manager of Nordic Mining Company. World market prices made it very difficult to market production at remunerative prices, he said, and "we should be happy to save the share capital without interest".

The company was started in 1952 with a capital of 15 million kroner. Later, the Danish State gave the company a loan of 12·5 million kroner and guaranteed an operation loan of 10 million kroner. Up to 1959, the company earned 32·1 million kroner from exports of concentrates. The figures for 1959 have not yet been completed. The mines at Mestersvig were originally estimated to contain enough concentrates for seven years' production, and the value was estimated at between 100 and 130 million kroner. However, the decline in world prices reduced the latter estimate considerably.

A Factory Move

Owing to the increasing demand for their products, **G. Hunter (London) Ltd.** have now closed their factory in South Benfleet and moved to Grays, Essex, where they have 15,000 ft^2 of factory space already completed and nearly an acre is concreted ready for additional buildings.

It is the company's intention to centralize as much as possible of its manufacturing capacity at the new factory so that it will eventually manufacture the complete range of products.

Demag Compressors

It is understood that the Compressor Division of Demag A.G., of Duisberg, have recently signed an agreement with **William H. Capper and Company Ltd.,** of London, under which the British firm are appointed sole representatives in the United Kingdom and Northern Ireland for the sale of all the products of the Division. These include reciprocating, turbo- and axial-flow and rotary compressors, centrifugal blowers, and a wide range of mining equipment.

The agreement covers only a very small part of Demag's output. Over 1,600 products of different kinds are manufactured at Duisberg, and the company's construction divisions are equipped to erect complete steel works, electro-metallurgical and electro-chemical plants, bridges, harbours, and steel constructions of every description.

Nickel Output

Abundant supplies of nickel for both military and civilian purposes were forecast by Dr. J. F. Thompson, chairman of the International Nickel Company of Canada, at a press conference in London last week. Vigorous development work is in progress to overcome the backlog caused by past years of shortages, and Dr. Thompson looks to stainless steel as the major improving outlet for more nickel. Other smaller expanding uses would be atomic reactors and gas turbines.

World production of nickel is expected to rise to around 600 million lb. by 1965, of which the International Nickel group will provide around 385 million lb. It is the stated aim of the industry to maintain a production surplus over consumption to ensure continuity of supply, but Dr. Thompson is optimistic that usage will develop roughly in line with the trend of production. Development of International Nickel's new project at Thompson, Manitoba is proceeding according to schedule, and sample operation will commence in the spring of 1960, rising to planned capacity of 75 million lb. in 1961.

Molybdenum in Sierra Leone

According to a report from the Government of Sierra Leone, molybdenum has been found in the Northern Province of the country. Scattered small occurrences of molybdenum minerals have been reported from time to time in Sierra Leone during the past twenty years, but it was not until 1951 that the Geological Department came on rather larger quantities than usual. These deposits were found north of the Sierra Leone Development Company's Tonkolili iron ore project, in the Lake Sonfon area of Koinadugu District.

The first holes that the Department dug were disappointing, and in 1956, helped by a team from Britain's Royal School of Mines, they began to search the surrounding neighbourhood by geochemical means. They found a stretch of hillside where the soil was much richer in molybdenum than normal, and two slanting drill holes were bored this year to probe the rocks underlying the site at vertical depths of up to 450 ft. Cores of rock taken from the holes contained enough molybdenum and lead minerals for experts to advise further drilling in the hope of uncovering a mine. Faint indications of molybdenum are fairly widespread round Lake Sonfon, and another team is to fly out from the Royal School of Mines next year to test stream and river water for molybdenum traces over an area of about 150 sq. miles. These tests may indicate additional places in which to dig or drill for molybdenum minerals.

Super purity (99·99%) aluminium used for the re-roofing of Eton College Chapel

Aluminium Roofing

On this page is illustrated part of the new roofing of Eton College Chapel, for which super purity aluminium was specified. All the materials included in the new roof of the chapel were chosen with the aim of providing the very highest standard of construction.

B.A. super purity (99.99 per cent)—aluminium in its purest form — was selected as it fulfilled this requirement, and because of its lightness, ease of working durability, and its ultimate weathering to an even medium-grey colour, in keeping with the original appearance of this fifteenth century chapel. The aluminium used was supplied by **The British Aluminium Company Limited.** Our photograph shows the preformed aluminium channels which replaced the customary wood rolls in the batten roll type roof covering. The roof construction contains no timber whatsoever.

The First 25 Years

This is the title of an interesting book published by **Star Aluminium Company Ltd.** to mark a step in their rapid development as one of the major producers of aluminium foil in the United Kingdom. It tells the story of the first twenty-five years of the company, the production of aluminium foil and the use of aluminium foil.

Metal Finishing

Advance notice is given of a Symposium on "Progress in Polishing" which has been arranged by the London branch of the **Institute of Metal Finishing** to take place on Wednesday, November 18, 1959, in the Recital Room of the Royal Festival Hall, London, S.E.1.

Proceedings will commence at 9.30 a.m. During the morning session two Papers will be presented, the first on "Automatic Polishing", by Mr. J. H. Bryan and J. P. Dewar, and the second on "Liquid Polishing Compounds", by Mr. J. Scouse. Following luncheon, the afternoon session will commence at 2 p.m., when two further Papers will be given, the first "Electrolytic and Chemical Polishing", by F. H. Wells, and the second "Barrel Polishing", by C. J. Kellard.

Admission is by ticket only, and applications for tickets should be made to Mr. S. W. Baier, 9E Cleveland Road, London, W.13, enclosing 32s. 6d. per ticket. This sum covers copies of Papers, morning coffee, buffet luncheon, and tea and biscuits.

An Industrial Film

Intended to interest non-technical audiences, a film entitled "Lead—The Enduring Metal" has been introduced by the **Lead Development Association.** This film has been designed to offer general information on lead. After briefly tracing its history and ancient usage, there is a description of the metal's occurrence in the world today, and how it is mined, smelted and refined.

The main sequences of this film demonstrate the versatile role played by lead in the modern world, and deal with applications which include sheet and pipe for building, paints, chemical engineering, lead shot, grids and oxides for storage batteries, type metals for printing, solder, electric cable sheaths and lead glass.

The film is 16 mm., runs for 28 min., is in sound and colour, and can be loaned free of charge on application to the association's offices.

City and Guilds Institute

New and revised schemes for the session 1959-60 are set out in a pamphlet just issued by the **City and Guilds of London Institute.** In a summary of the main changes in the regulations and syllabuses of existing subjects, and also of new schemes which are being introduced in the new session, it is interesting to note that in the non-ferrous operatives' course the examinations have been discontinued.

In the Chemical Plant Operation Department four new special chemical technology sections have been added to the final grade of this scheme, as follows: general industrial chemicals; fatty oils, soaps and detergents; atomic energy; and petroleum refining.

The syllabuses for Patternmaking and Foundry Practice have been completely revised. The new schemes place greater emphasis on practical work and involve less formal drawing work than in the former schemes (particularly in Foundry Practice). The conditions for the award of full technological certificates have been altered. The new schemes, involving examinations at Ordinary and Advanced levels, will come into operation in 1960.

The intermediate course in Instrument maintenance has been discontinued and in its place there is to be a three-year course leading to a Certificate in Instrument Maintenance (Ordinary Grade).

Change of Address

It is learned from **Colloidal Graphite Limited** that their offices and factory have been transferred to Sheaf Island Works, Pond Hill, Sheffield, 1. The telephone number is Sheffield 27397.

U.K. Metal Stocks

Stocks of refined tin in London Metal Exchange official warehouses at the end of last week fell 537 to 7,660 tons, comprising London 4,619, Liverpool 2,881, and Hull 160 tons.

Copper stocks fell 1,104 to 10,443 tons, distributed as follows: London 2,197, Liverpool 5,546, Birmingham 225, Manchester 2,375 and Hull 100 tons.

Forging Alloys

Information sheets have been issued by **Jessop-Saville Ltd.** giving the salient features of forging alloys designed for high temperature applications. These are discussed and presented in tabulated and graphical form to facilitate ease of selection and comparison.

These sheets are available from the company, together with others giving more detailed information on individual alloys.

Canadian Metals

Production of lead, nickel, silver and uranium in Canada was larger in July and the January-July period this year than last, while output of zinc was smaller in both periods. Production of copper at 36,067 tons was larger in July but smaller in the seven months' period, according to the Dominion Bureau of Statistics.

Greek Chrome Ore Exports

Figures published in Athens by the National Statistical Service show that 1,032,020 kilos of chrome ore were exported in August this year, compared with 1,296,000 kilos in July. The entire exports in August this year went to West Germany.

Soviet Aluminium Plant

According to the Russian news agency Tass, Russia is building one of its biggest aluminium plants in north-west Kazakhstan, site of the country's most promising deposit of bauxite. Tass, quoting speakers at a scientific conference in Alma-Ata, the Kazakhstan capital, said the deposit at Turgai was distinguished by its tremendous reserves, high aluminium content and convenient mining conditions. The aluminium obtained from it would be available in two years for building machines and producing cultural and

everyday necessities. A basically new method of processing bauxite would be used, cutting the cost of the plant and reducing the cost of the finished metal.

Street Lighting Competition

At the Royal Society of Arts on Wednesday last, awards were made to the prizewinners of the open competition for aluminium street lighting columns, organized by the **Aluminium Development Association.**

The awards were as follows: 1st prize, £250, to Mr. J. Howe, F.R.I.B.A., F.S.I.A., and Mr. J. B. Dwight, M.A., M.Sc., A.M.I.Mech.E.; 2nd and 3rd prizes, combined (£150), were divided equally between Mr. F. J. B. Rowley (student, College of Art and Industrial Design, Newcastle upon Tyne) and Mr. S. L. Devlin (student, Royal College of Art, London). Mr. Devlin and Mr. Rowley also shared the students' prize of £75.

In their joint report, the assessors reached the conclusion that team work between specialists—architects, designers and structural engineers—is essential if designs are to be completely functional, practical to make and really distinguished to look at. They expressed disappointment that no entry could be deemed by them worthy of the second prize, and it was in these circumstances that the Association combined the second and third prizes, and divided them equally between the two entrants coming next in the assessors' opinion.

The purpose of this competition was to encourage the evolution of good designs, which should take into account aesthetic appearance, economy of construction and the advantages of aluminium. This use of aluminium is one in which Great Britain lags behind some European countries and North America.

In this country, street lighting columns are divided into two groups: Group A, for trunk road lighting, and Group B, for non-trunk road lighting. (The A.D.A. competition was for designs of either type.) It was to encourage the development of well designed British lighting columns that the A.D.A. inaugurated its Street Lighting Competition.

Cornish Tin Ore

One of the several interesting articles contained in "Ingot", the quarterly magazine of **Richard Thomas and Baldwins Ltd.,** is that dealing with Cornish tin, in which notes on the two working mines that are all that remain of a once flourishing industry are discussed, as well as a brief history of Cornwall as a mining area. Another article deals with the great steel plant being built by a British consortium at Durgapur, in West Bengal.

Technology and Commerce

Organized by the Royal Society of Arts, London, three Cantor lectures on "Modern Technological and Commercial Education" will be delivered on Mondays, November 9, 16 and 23, at 6 p.m. The first lecture will be given by Mr. A. A. Part, C.B., M.B.E., Under-Secretary, Ministry of Education; the second lecture by Dr. P. F. R. Venables, Ph.D., B.Sc., F.R.I.C., Principal, College of Advanced Technology, Birmingham; and the third lecture by Dr. A. J. McIntosh, B.Com., Ph.D., Director, City of London College.

Full details of these lectures may be obtained from the offices of the Society at John Adam Street, Adelphi, London, W.C.2.

Men and Metals

It has been announced by Sir W. H. Bailey and Company Limited that **Mr. A. Kirkham** has resigned from the board of directors and has joined the Foundries Division of David Brown (Industries) Limited.

To succeed **Dr. Maurice Cook,** C.B.E., who is to retire at the end of this year, **Mr. Michael J. S. Clapham** has been appointed chairman of the Metals Division of Imperial Chemical Industries Limited. Mr. Clapham has been joint managing director of the Division since October, 1952. He joined the Division in 1938, and in 1942 was seconded to the directorate

of Tube Alloys (Atomic Energy) Department of Scientific and Industrial Research to develop the work started in the Kynoch Press on producing barriers for an isotope diffusion plant. In 1944, he was appointed personnel manager, and a year later personnel director of I.C.I. Metals Division. Mr. Clapham is also a director of Yorkshire Imperial Metals, Imperial Aluminium Company, and Pyrotenax Limited. He is chairman of the Non-Ferrous Wrought Metals Export Group and a vice-president of the British Non-Ferrous Metals Federation.

The election of **Mr. Edward A. Smith** to the board of directors of Acheson Colloids Limited has been announced by Acheson Industries (Europe) Limited. Mr. Smith was technical manager of Acheson Colloids Limited before being promoted to his present senior position of executive manager, Acheson Industries (Europe) Limited.

An invitation to join the board of the Timken Roller Bearing Company, of Canton, Ohio, has been accepted by **Sir John Pascoe,** chairman of British Timken Limited.

We learn from the Electric Resistance Furnace Company Limited that **Mr. B. Malone** has joined the staff of the company as manager of the new Efco foundry division. He is a member of the Institute of British Foundrymen, and has been for many years works manager of Southern Foundries Limited.

Until recently the sales manager of the United Insulator Division of the Telegraph Condenser Company Limited, **Mr. C. Glover** has been appointed general manager of the division. His place as sales manager has been taken by **Mr. B. E. J. Honey.**

Chief engineer since the inception of the company, **Mr. J. W. Ashley,** B.Sc., has been elected to the board of Atomic Power Constructions Limited as technical director. Mr. Ashley heads the team responsible for the design and construction of the 500 MW nuclear power station now being built by the company for the Central Electricity Board at Trawsfynydd, in North Wales.

News from the Sheffield Wire Rope Company Limited, one of the Firth Cleveland group of companies, is that **Mr. L. B. Devins** has been appointed general manager of the company. He was formerly sales manager, steel rope department, of Wrights Ropes Limited.

It is interesting to learn from The Carborundum Company Limited that their film producer, **Mr. F. G. Harris,** has been honoured with the Fellowship of the British Kinematograph Society. This is believed to be the first occasion on which such an honour has been bestowed on an industrial film producer within industry.

News from the 600 Group is that **Mr. Michael George Cohen** is taking up residence immediately in the United States as a vice-president of George Cohen 600 Incorporated, the American company of the British concern. Mr. Cohen will play an active part in the company's trading, both domestic and international, in steel and allied products.

Forthcoming Meetings

October 27—Institute of British Foundrymen. Slough Section. Lecture Theatre, High Duty Alloys Limited, Slough. "Casting Defects." J. L. Francis. 7.30 p.m.

October 27 — Institution of Plant Engineers. South Wales Branch. South Wales Engineers' Institution, Park Place, Cardiff. "Properties of Molybdenum Disulphide and its Use as Plant Engineering Material." H. Peter Jost.

October 28 — Manchester Metallurgical Society. The Manchester Room of The Central Library, Manchester. "Metallurgical Research in the U.S.S.R." K. J. Irvine. 6.30 p.m.

October 29—Southampton Metallurgical Society. Engineering Block, Southampton University. "The Nimonic Alloys." W. Betteridge. 7.15 p.m.

October 29 — Birmingham Metallurgical Society and **Birmingham Local Section of the Institute of Metals.** Joint Meeting. College of Technology, Gosta Green, Birmingham, 4. Presidential Address. S. G. Temple. 6.30 p.m.

October 30—Institute of Metal Finishing. Sheffield and North-East Branch. Grand Hotel, Sheffield. Open Evening Discussion. Chairman—C. Wharrad. 7 p.m.

Metal Market News

LAST week saw the publication of the August statistics by the British Non-Ferrous Metals Statistical Bureau and, as might be expected of a holiday month, these were not very good. July, of course, showed a decline in usage compared with June, and August saw this downward trend extended further. In copper, the consumption for the month was 30,886 tons of refined, against 32,454 tons in July, and only 9,735 tons of secondary, compared with 14,798 tons. This meant a drop of about 6,700 tons on the total, which is a pretty considerable figure. Stocks in the U.K. advanced from 81,986 tons at the end of July to 89,483 tons at August 31. In lead, overall consumption dropped back from 26,851 tons to 23,358 tons, while stocks were about 1,500 tons down at 66,048 tons. In zinc, a fall of about 4,500 tons in consumption was reported, the August figure being 21,566 tons, while stocks rose by nearly 3,000 tons to 40,358 tons. Consumption of tin was only 1,224, or 458 tons lower than July. The Copper Institute, too, has released the September figures for the U.S.A. and the world, which are given as follows, in short tons of 2,000 lb. In the States, last month's output of crude copper was 25,743 tons, against 55,271 tons in August. The output of refined metal amounted to only 28,847 tons, compared with 81,176 tons in August. Domestic deliveries amounted to 92,501 tons, against 90,123 tons in the previous month, while stocks of refined copper in producers' hands were 61,524 tons, a decline of a little over 30,000 tons.

Outside the United States, there was also a drop in stocks, but this was not so drastic as in America, for the figures were 275,100 tons at September 30 compared with 284,540 tons a month earlier. On the production side, the output of crude copper was 168,122 tons, compared with 182,175 tons in August, while in refined copper the figure was 142,646 tons, compared with 142,276 tons. Deliveries to consumers registered a drop of a little over 8,000 tons to 139,781 tons. While, as will be seen, little change has taken place in the details of activity outside the United States, there has been, inside the U.S.A., a very marked decline both in production and in the reserves. In fact, the combined stocks registered a drop of 39,524 tons, and as things look at the moment, it seems highly probable that October will show a further deterioration in the stock position. A recent estimate of the amount of copper already lost through the U.S.A. strike gives a figure of 125,000 tons, which is certainly no mean tonnage. As we write, no settlement has been reached and the El Teniente strike also continues.

One piece of good news last week was the ending of the longshoremen's strike, which had already caused so much hardship and delay to goods. For the standard copper market this was a bull point, since it made shipments into America once again possible. At the beginning of the week L.M.E. warehouse stocks were reported to be 1,516 tons down at 11,547 tons, but selling depressed the price at the beginning of the week to £230 10s. 0d. A steady improvement, however, was seen and by Thursday the settlement price had advanced to £234 15s. 0d. Rather surprisingly, in view of the big stock reduction, the week finished at £234 5s. 0d. cash and £233 15s. 0d. three months, a gain of £2 5s. 0d. in prompt and £1 15s. 0d. forward. The turnover was 17,450 tons, well above the average. Tin closed at £794 10s. 0d. cash (unchanged) and £794 three months (£1 down). Lead, on a turnover of 8,325 tons, was practically unchanged at £70 10s. 0d. and £71 12s. 6d. Zinc did well throughout the week and was an active market, the turnover last Friday alone being 1,075 tons. Prompt closed £3 15s. 0d. up at £90 15s. 0d. and forward £3 5s. 0d. higher at £88 10s. 0d.

New York

Commodity Exchange copper, after early steadiness, slipped on some profit-taking over the week-end. Some trade sources said that September copper figures were bullish; others said they were disappointing, particularly the small drop in foreign stocks. Buying interest in dealer physical copper was quiet and the undertone steady. Tin was softer, reflecting the decline abroad. Consumer interest was negligible. Lead and zinc were quiet. In the closing stage, tin was quiet and steady. Copper, lead and zinc were unchanged.

United States industrial production in September declined only one point to 148 per cent of the 1947-49 average, despite the steel strike. The Federal Reserve Board, which announced the figure, pointed out that at mid-October "inventories of steel were being rapidly depleted and output curtailments among steel consuming industries were spreading". The Board also said the copper strike, which began in August, was holding down output in non-ferrous mining and manufacturing industries. However, it said pre-strike inventories allowed most machinery and durable goods industries to maintain production.

Birmingham

The all-round improvement in industry which has taken place in the Midland area during the last few weeks is maintained. Many firms are busier than they have been at any time in the last twelve months, and the number of people at work is correspondingly greater. Light engineering industries are using larger quantities of raw materials, and some local firms are getting a share of contracts given out by the Atomic Energy Commission. The motor trade continues to make record outputs. Exports, particularly to North America, are expanding, and the waiting list for the popular types of cars in the home market are lengthening.

Production of iron and steel seems likely to rise further as demand increases in the consuming industries. Recent figures show considerable expansion compared with a year ago. Even so, there is a shortage of the special sheets used in the motor trade. For ordinary sheets, the supply is equal to demand and delivery dates are reasonable. Re-rolling firms are busy on small sections and bars. Demand for constructional steel is moving ahead, and plate mills are steadily employed. There is a good market for heavy castings from the engineering industries. Supplies of pig iron are sufficient to meet all requirements, but if the present trend continues it will be necessary to bring idle furnaces into activity again.

Malaya

Mining experts in Kuala Lumpur say that more land must be found for tin mining if the tin industry is to survive. They were commenting on a warning by Sir Douglas Waring, a leading figure in the industry, that the industry faced possible extinction from over-high prices.

Mr. H. M. Fuller, a member of the Federated Malay State Chamber of Mines, said there was no doubt that the industry's problems were increasing due to shortage of mining land. He said "prospecting licences are not issued fast enough to cope with demand. All reserves have been eaten up quicker than new mining land is being found". Mr. Chong Khoon Ling, chairman of the All-Malaya Chinese Mining Association, said: "We are using up all our resources. If we cannot fulfil the demand, America and other countries will try and produce synthetic tin." There was not enough land available for prospecting, he added.

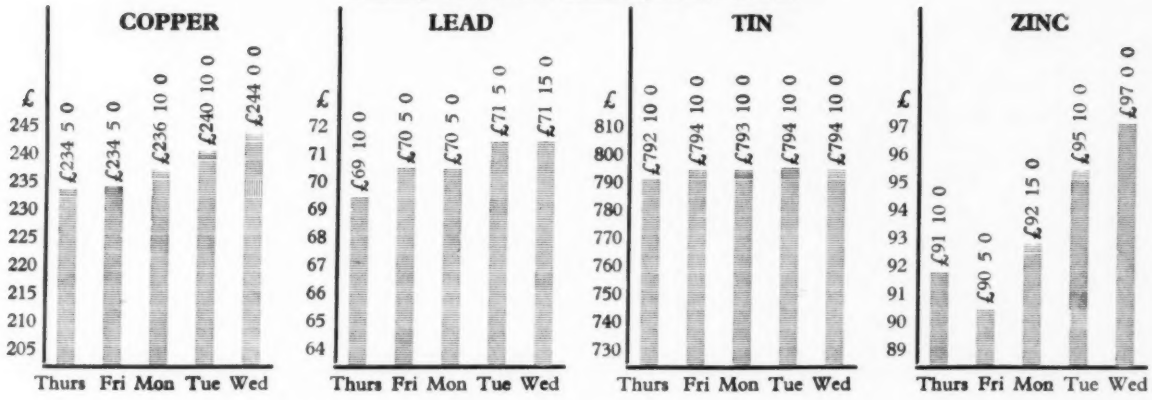
Paris

A firm tone ruled last week on the Paris scrap market in improved activity. This was mainly due to the expected opening of quotas for the export of copper, brass and bronze scrap to member-countries of the O.E.E.C. Buying of copper products was more active, and prices firmed. A good demand was also reported for aluminium and zinc.

Non-Ferrous Metal Prices

London Metal Exchange

Thursday 15 October to Wednesday 21 October 1959



Primary Metals

All prices quoted are those available at 2 p.m. 21/10/59

		£	s.	d.
Aluminium Ingots	ton	180	0	0
Antimony 99·6%	,,	197	0	0
Antimony Metal 99%	,,	190	0	0
Antimony Oxide	,,	180	0	0
Antimony Sulphide Lump	,,	190	0	0
Antimony Sulphide Black Powder	,,	205	0	0
Arsenic	,,	400	0	0
Bismuth 99·95%	lb.		16	0
Cadmium 99·9%	,,		9	0
Calcium	,,	2	0	0
Cerium 99%	,,	16	0	0
Chromium	,,		6	11
Cobalt	,,		14	0
Columbite	per unit		—	
Copper H.C. Electro	ton	244	0	0
Fire Refined 99·70%	,,	243	0	0
Fire Refined 99·50%	,,	242	0	0

		£	s.	d.
Copper Sulphate	ton	76	0	0
Germanium	grm.		—	
Gold	oz.	12	9	10¼
Indium	,,		10	0
Iridium	,,	24	0	0
Lanthanum	grm.		15	0
Lead English	ton	71	15	0
Magnesium Ingots	lb.		2	3
Notched Bar	,,		2	9½
Powder Grade 4	,,		6	1
Alloy Ingot, A8 or AZ91	,,		2	4
Manganese Metal	ton	245	0	0
Mercury	flask	71	10	0
Molybdenum	lb.	1	10	0
Nickel	ton	600	0	0
F. Shot	lb.		5	5
F. Ingot	,,		5	6
Osmium	oz.		nom.	
Osmiridium	,,		nom.	

		£	s.	d.
Palladium	oz.	7	5	0
Platinum	,,	28	10	0
Rhodium	,,	41	0	0
Ruthenium	,,	18	0	0
Selenium	lb.		nom.	
Silicon 98%	ton		nom.	
Silver Spot Bars	oz.		6	10½
Tellurium	lb.		15	0
Tin	ton	794	10	0
***Zinc**				
Electrolytic	ton		—	
Min 99·99%	,,		—	
Virgin Min 98%	,,	95	0	0
Dust 95/97%	,,	114	0	0
Dust 98/99%	,,	120	0	0
Granulated 99+%	,,	120	0	0
Granulated 99·99+%	,,	136	17	6

**Duty and Carriage to customers' works for buyers' account.*

Foreign Quotations

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

	Belgium fr/kg ≏ £/ton	**Canada** c/lb ≏ £/ton	**France** fr/kg ≏ £/ton	**Italy** lire/kg ≏ £/ton	**Switzerland** fr/kg ≏ £/ton	**United States** c/lb ≏ £/ton
Aluminium		22.50 185 17 6	224 168 0	375 221 5	2.50 212 10	26.80 214 10
Antimony 99.0			230 171 10	445 262 10		29.00 232 0
Cadmium			1,300 975 0			120.00 960 0
Copper						
Crude						
Wire bars 99.9				455 268 10		
Electrolytic	32.25 237 10	29.00 238 12 6	324 243 0		2.65 225 5	30.00 240 0
Lead		10.75 88 12 6	102 71 12 6	161 94 17 6	.87 73 17 6	13.00 104 0
Magnesium						
Nickel		70.00 578 5	900 675 0	1,200 708 0	7.50 637 10	74.00 592 0
Tin	110.75 817 2 6		1,123 842 2 6	1,500 885 0	9.70 824 12 6	103.25 826 0
Zinc						
Prime western		11.75 97 0 0				
High grade 99.95		12.35 102 0 0				
High grade 99.99		12.75 105 2 6				
Thermic			127.00 95 2 6			
Electrolytic			135.00 101 2 6	192 113 5	1.05 89 2 6	13.50 108 0

Non-Ferrous Metal Prices (continued)

Ingot Metals

All prices quoted are those available at 2 p.m. 21/10/59

Aluminium Alloy (Virgin)	£	s.	d.
B.S. 1490 L.M.5 .... ton	210	0	0
B.S. 1490 L.M.6 .... „	202	0	0
B.S. 1490 L.M.7 .... „	216	0	0
B.S. 1490 L.M.8 .... „	203	0	0
B.S. 1490 L.M.9 .... „	203	0	0
B.S. 1490 L.M.10.... „	221	0	0
B.S. 1490 L.M.11.... „	215	0	0
B.S. 1490 L.M.12.... „	223	0	0
B.S. 1490 L.M.13.... „	216	0	0
B.S. 1490 L.M.14.... „	224	0	0
B.S. 1490 L.M.15.... „	210	0	0
B.S. 1490 L.M.16.... „	206	0	0
B.S. 1490 L.M.18.... „	203	0	0
B.S. 1490 L.M.22.... „	210	0	0
Aluminium Alloys (Secondary)			
B.S. 1490 L.M.1 .... ton	152	0	0
B.S. 1490 L.M.2 .... „	162	0	0
B.S. 1490 L.M.4 .... „	178	0	0
B.S. 1490 L.M.6 .... „	188	0	0
***Aluminium Bronze**			
BSS 1400 AB.1..... ton	243	0	0
BSS 1400 AB.2..... „	254	0	0

*Brass	£	s.	d.
BSS 1400-B3 65/35 .. ton	158	0	0
BSS 249..... „		—	
BSS 1400-B6 85/15 .. „	206	0	0
***Gunmetal**			
R.C.H. 3/4% ton .... „		—	
(85/5/5/5) LG2 ..... „	197	0	0
(86/7/5/2) LG3 ..... „	207	0	0
(88/10/2/1)..... „	246	0	0
(88/10/2/½) ..... „	258	0	0
***Manganese Bronze**			
BSS 1400 HTB1 .... „	191	0	0
BSS 1400 HTB2 .... „	208	0	0
BSS 1400 HTB3 .... „	220	0	0
Nickel Silver			
Casting Quality 12% „	234	0	0
„ „ 16% „	240	0	0
„ „ 18% „	260	0	0
***Phosphor Bronze**			
B.S. 1400 P.B.1. (A.I.D. released)..... „	292	0	0
B.S. 1400 L.P.B.1.... „	275	0	0

**Average prices for the last week-end.*

Phosphor Copper	£	s.	d.
10% ..... ton	253	0	0
15% ..... „	255	0	0
Phosphor Tin			
5% ..... „		—	
Silicon Bronze			
BSS 1400-SB1 ..... „	250	0	0
Solder, soft, BSS 219			
Grade C Tinmans.... „	369	10	0
Grade D Plumbers .. „	297	0	0
Grade M ..... „	405	10	0
Solder, Brazing, BSS 1845			
Type 8 (Granulated) lb.		—	
Type 9 „		—	
Zinc Alloys			
B.S.S.1004 Alloy A .. ton	130	2	6
B.S.S.1004 Alloy B .. „	134	2	6
Sodium-Zinc ..... lb.		2	8½

Semi-Fabricated Products

Prices vary according to dimensions and quantities. The following are the basis prices for certain specific products.

Aluminium				£	s.	d.
Sheet	10	S.W.G.	lb.		2	8½
Sheet	18	S.W.G.	„		2	10½
Sheet	24	S.W.G.	„		3	1½
Strip	10	S.W.G.	„		2	8½
Strip	18	S.W.G.	„		2	9½
Strip	24	S.W.G.	„		2	11
Circles	22	S.W.G.	„		3	2½
Circles	18	S.W.G.	„		3	1½
Circles	12	S.W.G.	„		3	0½
Plate as rolled			„		2	8
Sections			„		3	2
Wire 10 S.W.G.			„		2	11½
Tubes 1 in. o.d. 16 S.W.G.			„		4	1
Aluminium Alloys						
BS1470. HS10W.						
Sheet	10	S.W.G.	„		3	1
Sheet	18	S.W.G.	„		3	3½
Sheet	24	S.W.G.	„		3	11
Strip	10	S.W.G.	„		3	1
Strip	18	S.W.G.	„		3	2½
Strip	24	S.W.G.	„		3	10½
BS1477. HP30M. Plate as rolled			„		2	11
BS1470. HC15WP.						
Sheet	10	S.W.G.	„		3	9½
Sheet	18	S.W.G.	„		4	2
Sheet	24	S.W.G.	„		5	0½
Strip	10	S.W.G.	„		3	10½
Strip	18	S.W.G.	„		4	2
Strip	24	S.W.G.	„		4	9½
BS1477. HPC15WP. Plate heat treated..			„		6	3½
BS1475. HG10W. Wire	10	S.W.G.	„		3	10½
BS1471. HT10WP. Tubes 1 in. o.d. 16 S.W.G.			„		5	0½
BS1476. HE10WP. Sections			„		3	1½
Brass						
Tubes			„		1	11⅜
Brazed Tubes.....			„		3	1½
Drawn Strip Sections			„		3	1¾
Sheet			ton	209	0	6
Strip			„	209	0	6
Extruded Bar.....			lb.		2	0¾
Extruded Bar (Pure Metal Basis)			„		—	

Brass		£	s.	d.
Condenser Plate (Yellow Metal)	ton	191	0	0
Condenser Plate (Naval Brass)	„	203	0	0
Wire	lb.		2	9
Beryllium Copper				
Strip	„	1	4	11
Rod	„	1	1	6
Wire	„	1	4	9
Copper				
Tubes	lb.		2	8⅞
Sheet	ton	270	5	0
Strip	„	270	5	0
Plain Plates	„		—	
Locomotive Rods	„		—	
H.C. Wire	„	285	5	0
Cupro Nickel				
Tubes 70/30	lb.		3	6½

Lead		£	s.	d.
Pipes (London)	ton	111	5	0
Sheet (London)	„	109	0	0
Tellurium Lead	„	£6 extra		
Nickel Silver				
Sheet and Strip 7% ..	lb.		3	8½
Wire 10%	„		4	3½
Phosphor Bronze				
Wire	„		4	1⅛
Titanium (1,000 lb. lots)				
Billet 4½" to 18" dia...	lb.	54/-		55/-
Rod ¼" to 4" dia.	„	95/-		62/-
Wire ·036"-·232" dia.	„	167/-		110/-
Strip ·003" to ·048" ..	„	200/-		75/-
Sheet 8′×2′. 20 gauge	„	85/-		
Tube, representative average gauge	„	300/-		
Extrusions	„	105/-		
Zinc				
Sheet	ton	129	5	0
Strip	„	nom.		

Domestic and Foreign

Merchants' average buying prices delivered, per ton, 20/10/59.

Aluminium	£
New Cuttings	150
Old Rolled	132
Segregated Turnings	104
Brass	
Cuttings	166
Rod Ends	151
Heavy Yellow	125
Light	119
Rolled	156
Collected Scrap	120
Turnings	144
Copper	
Wire	213
Firebox, cut up	205
Heavy	200
Light	193
Cuttings	213
Turnings	195
Braziery	163

Gunmetal	£
Gear Wheels	175
Admiralty	175
Commercial	162
Turnings	157
Lead	
Scrap	60
Nickel	
Cuttings	—
Anodes	550
Phosphor Bronze	
Scrap	162
Turnings	157
Zinc	
Remelted	78
Cuttings	63
Old Zinc	42

Metal Statistics

Detailed figures of the consumption and output of non-ferrous metals for the month of Aug., 1959, have been issued by the British Bureau of Non-Ferrous Metal Statistics, as follows in long tons:—

COPPER	Gross Weight	Copper Content
Wire	16,116	15,800
Rods, bars and sections	11,239	7,315
Sheet, strips and plate	9,710	7,608
Tubes	5,504	5,104
Castings and miscellaneous	5,763	—
Sulphate	214	—
	48,546	40,621
Of which:		
Consumption of Virgin Copper		32,886
Consumption of Copper and Alloy Scrap (Copper Content)		9,735

LEAD	
Cables	6,573
Batteries	2,116
Battery Oxides	1,978
Tetra Ethyl Lead	1,966
Other Oxides and Compounds	1,285
White Lead	558
Shot	224
Sheet and Pipe	4,540
Foil and Collapsible Tubes	232
Other Rolled and Extruded	551
Solder	1,004
Alloys	1,092
Miscellaneous Uses	1,189
Total	23,358

TIN	
Tinplate	415
Tinning:	
Copper Wire	36
Steel Wire	8
All other	57
Solder	158
Alloys	392
Foil and Collapsible Tubes, etc.	38
Tin Compounds, Salts, and Miscellaneous Uses	120
Total Consumption	1,224

ZINC	
Galvanizing	6,385
Brass	7,248
Rolled Zinc	1,442
Zinc Oxide	1.850
Zinc Die-casting alloy	3,069
Zinc Dust	725
Miscellaneous Uses	847
Total, All Trades	21,566
Of which:	
High purity 99·99 per cent	3,320
Electrolytic and high grade 99·95 per cent	3,994
Prime Western, G.O.B. and debased	8,195
Remelted	408
Scrap Brass and other Cu alloys	3,385
Scrap Zinc, alloys and residues	2,069

ANTIMONY	
Batteries	85
Other Antimonial Lead	30
Bearings	26
Oxides—for White Pigments	96
Oxides—other	50
Miscellaneous Uses	13
Sulphides	5
Total Consumption	305
Antimony in Scrap	
For Antimonial Lead	265
For Other Uses	9
Total Consumption	274

CADMIUM	
Plating Anodes	35·05
Plating Salts	6·85
Alloys: Cadmium Copper	2·35
Alloys: Other	2·70
Batteries: Alkaline	5·45
Batteries: Dry	0·35
Solder	4·50
Colours	16·75
Miscellaneous Uses	1·55
Total Consumption	75·55

Scrap Metal Prices

The figures in brackets give the English equivalents in £1 per ton:—

West Germany (D-marks per 100 kilos):		
Used copper wire	(£210.2.6)	240
Heavy copper	(£197.0.0)	225
Light copper	(£166.10.0)	190
Heavy brass	(£118.5.0)	135
Light brass	(£87.12.6)	100
Soft lead scrap	(£56.0.0)	64
Zinc scrap	(£43.7.6)	50
Used aluminium unsorted	(£105.2.6)	120
France (francs per kilo):		
Electrolytic copper scrap	(£202.10.0)	270
Heavy copper	(£202.10.0)	270
No. 1 copper wire	(£187.12.6)	250
Brass rod ends	(£135.0.0)	180
Zinc castings	(£56.2.6)	75
Lead	(£69.0.0)	92
Aluminium	(£135.0.0)	180

Italy (lire per kilo):		
Aluminium soft sheet clippings (new)	(£200.15.0)	340
Aluminium copper alloy	(£135.17.6)	240
Lead, soft, first quality	(£79.0.0)	134
Lead, battery plates	(£44.5.0)	75
Copper, first grade	(£221.5.0)	375
Copper, second grade	(£209.10.0)	355
Bronze, first quality machinery	(£203.2.6)	345
Bronze, commercial gunmetal	(£174.10.0)	295
Brass, heavy	(£147.12.6)	250
Brass, light	(£237.17.6)	225
Brass, bar turnings	(£135.17.6)	230
New zinc sheet clippings	(£65.0.0)	110
Old zinc	(£50.2.6)	85

Financial News

John Dale Limited

Discussions on the terms of the proposed merger announced recently between Metal Closures Limited and John Dale Limited are in an advanced stage, and it is expected that the merger proposals will be sent to shareholders shortly. Shareholders are advised to take no action on the offer of 19s. per share made on behalf of Winterbottom Industries Limited, which was sent to shareholders, until they receive details of the merger terms and the directors' recommendations.

Serck Ltd.

A final dividend of 12½ per cent is announced, making 17½ per cent for the year to August 31, against 15 per cent. In addition, the directors announce a special distribution of 1½d. per share out of investment profits and further encourage shareholders with a one-for-two scrip issue.

Canadian British Aluminium

It is reported from Montreal that the company shows a net loss of 621,085 dollars for the seven months ended July 31, compared with a net loss of 1,914,229 dollars for the year ended December 31, 1958. The company recently changed its fiscal year. In his report to shareholders, Sir Ivan Stedeford, the company chairman, said the net loss was lower than estimated, despite the lower price and reduced sales of aluminium. While a major part of the sales were to the United Kingdom, progress was being made in developing sales to Canada.

He said that the final cost of the Baie Comeau Smelter and its ancillaries, excluding housing, was less than one per cent above the estimated cost. The company would ship from Baie Comeau throughout the coming winter, with firm arrangements for shipments in January, February and March, 1960. Winter navigation was important to the company in terms of inventories and working capital requirements, Sir Ivan added.

Richard Johnson, Clapham

Accounts for the year ended June 30 last of Richard Johnson, Clapham and Morris show group profit at £57,229 (£76,280), subject to tax of £20,724 (£36,277) and dividend 20 per cent (same). Current assets were £887,456 (£887,483) and liabilities £738,669 (£733,210), including bank overdraft £237,086 (£209,462).

LIGHT METALS STATISTICS IN JAPAN
(June, 1959)

Classification	Production	Shipment	Stock	Export
Alumina	23,983	25,536	8,651	11,331
Aluminium				
Primary	8,277	8,711	1,276	1
Secondary	2,955	2,918	412	0
Rolled Products	8,035	8,069	1,757	676
Electric Wire	1,052	1,258	610	114
Sheet Products	1,642	1,591	1,359	100
Castings	2,374	—	—	—
Die-Castings	1,400	—	—	—
Forgings	34	—	—	—
Powder	—	—	—	—
Primary Aluminium (July)	8,871	8,919	1,227	0
Sponge Titanium	213	119	827	111
Magnesium	134	133	1	0
Secondary	235	279	145	0

THE STOCK EXCHANGE

Continued Excited Buying Has Again Put Prices Up Sharply

ISSUED CAPITAL •	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 19 OCTOBER	+RISE — FALL	DIV. FOR LAST FIN. YEAR	DIV. FOR PREV. YEAR	DIV. YIELD	1959 HIGH	1959 LOW	1958 HIGH	1958 LOW
£	£				Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation ...	27/6	—3d.	9	9	6 10 9	28/–	23/3	24/9	17/6
400,000	2/–	Anti-Attrition Metal	1/3		4	8½	6 15 0	1/6	1/3	1/9	1/3
41,303,829	Stk. (£1)	Associated Electrical Industries ...	66/9	+2/6	15	15	4 10 0	66/10½	54/–	58/9	46/6
1,613,280	1	Birfield	64/6	+5/–	15	15	4 13 0	64/6	46/9	62/4½	46/3
3,196,667	1	Birmid Industries	98/6	+13/–	17½	17½	4 1 9	100/–	72/–	77/6	55/3
5,630,344	Stk. (£1)	Birmingham Small Arms	52/6	+2/6	11	10	4 3 9	52/6	36/1½	39/–	23/9
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	15/9		5	5	6 7 0	16/3	15/–	16/1½	14/7½
350,580	Stk. (£1)	Ditto Cum. B. Pref. 6%	18/7½		6	6	6 8 9	18/10½	17/9	17/4½	16/6
500,000	1	Bolton (Thos.) & Sons	34/6		10	10	5 16 0	34/6	27/6	28/9	24/–
300,000	1	Ditto Pref. 5%	15/–		5	5	6 13 3	15/6	14/–	16/–	15/–
160,000	1	Booth (James) & Co. Cum. Pref. 7%	20/6		7	7	6 16 6	20/6	20/–	20/4½	19/–
1,500,000	Stk. (£1)	British Aluminium Co. Pref. 6% ...	19/9		6	6	6 1 6	20/7½	18/9	20/–	18/4½
17,247,070	Stk. (£1)	British Insulated Callender's Cables	57/6		12½	12½	4 7 0	59/6	46/3	52/6	38/9
17,047,166	Stk. (£1)	British Oxygen Co. Ltd., Ord. ...	75/6	+3/–	10	10	2 13 0	77/–	49/3	52/–	28/3
1,200,000	Stk. (5/–)	Canning (W.) & Co.	14/6	—4½d.	25+ *2½C‡	25	4 6 3	16/–	12/3	25/3	19/3
60,484	1/–	Carr (Chas.)	1/10½	+3d.	12½	25	6 13 9	2/10½	1/3	2/3	1/4½
555,000	1	Clifford (Chas.) Ltd.	26/3		10	10	7 12 6	27/–	22/6	22/–	16/–
45,000	1	Ditto Cum. Pref. 6%	16/9		6	6	7 3 3	17/–	15/3	16/–	15/–
250,000	2/–	Coley Metals	3/–		15	20	10 0 0	4/–	2/10½	4/6	2/6
10,185,696	1	Cons. Zinc Corp.†	67/6	+4/–	15	18¾	4 9 6	69/3	59/–	65/3	41/–
1,509,528	1	Davy & United	97/–	+1/–	30‡	20	3 7 6	98/6	43/1½	87/–	45/9
6,840,000	5/–	Delta Metal	20/4½	—1½d.	31‡	30	3 15 9	21/–	12/–	25/–	17/7½
5 296,550	Stk. (£1)	Enfield Rolling Mills Ltd.	58/–	+6d.	15	12½	5 3 6	58/6	36/7½	38/–	22/9
750,000	1	Evered & Co.	35/4½		10§	15D	5 13 0	35/9	30/–	30/–	26/–
18,000,000	Stk. (£1)	General Electric Co.	47/–	+1/–	10	10P	4 5 0	47/–	30/–	40/6	29/6
1,500,000	Stk. (10/–)	General Refractories Ltd.	43/3		20	20	4 12 6	43/3	31/9	39/3	27/3
401,240	1	Gibbons (Dudley) Ltd.	63/–		16½	15	5 4 9	66/6	63/–	67/6	61/–
750,000	5/–	Glacier Metal Co. Ltd.	9/–	+6d.	11½	11½	6 7 9	9/3	6/7½	8/3	5/–
1,750,000	5/	Glynwed Tubes	23/–	+10½d.	20¶	20	4 15 9	23/7½	16/4½	18/1½	12/10½
5,421,049	10/–	Goodlass Wall & Lead Industries ...	48/6xd	+2/3	13‖	18D	2 15 0	48/6	28/7½	30/9	17/3
342,195	1	Greenwood & Batley	105/–		30	20	5 14 3	108/3	75/–	57/9	45/–
396,000	5/–	Harrison (B'ham) Ord.	23/–	+2/3	*17½	*15	3 16 0	23/–	14/11½	15/9	11/6
150,000	1	Ditto Cum. Pref. 7%	19/6		7	7	7 3 6	19/6	19/3	19/9	18/4½
1,075,167	5/–	Heenan Group	13/3	+9d.	10	10‡	3 15 6	13/3	7/6	9/7½	6/9
246,209,422	Stk. (£1)	Imperial Chemical Industries ...	54/3	+6d.	12 DZ	10	2 19 0	54/6	33/9	38/–	24/3
34,736,773	Stk. (£1)	Ditto Cum. Pref. 5%	17/6	+4½d.	5	5	5 14 3	17/10½	16/–	17/1½	16/–
14,584,025	**	International Nickel	172	+3	$2.60	$3.75	2 14 0	187½	154½	169	132½
300,000	1	Johnson, Matthey & Co. Cum. Pref. 5%	15/9		5	5	6 7 0	16/3	15/4½	16/9	15/–
6,000,000	1	Ditto Ord.	45/–	+1/3	12D	10	3 11 3	46/3	29/7½	47/–	36/6
600,000	10/–	Keith, Blackman	31/3		17½E	15	4 7 0	31/3	25/–	28/9	15/–
320,000	4/–	London Aluminium	6/4½	—3d.	10	10	6 5 6	6/9	5/3	6/–	3/–
765,012	1	McKechnie Brothers Ord.	46/–		15	15	6 10 6	45/–	41/–	45/–	32/–
1,530,024	1	Ditto A Ord.	44/–	+1/–	15	15	6 15 0	44/–	38/9	45/–	30/–
1,108,268	5/–	Manganese Bronze & Brass	18/–	+2/–	20§	20	5 12 9	18/–	13/9	14/1½	8/9
50,628	6/–	Ditto (7½% N.C. Pref.)	6/–		7½	7½	7 10 0	—	—	6/3	5/6
13,098,855	Stk. (£1)	Metal Box	72/–	+6d.	11	11	3 1 6	80/–	44/7½	73/3	40/6
415,760	Stk. (2/–)	Metal Traders	10/–	—9d.	50	50	10 0 0	12/3	8/4½	9/–	6/3
160,000	1	Mint (The) Birmingham	29/–	+6/–	10	10	6 18 0	29/–	22/–	22/9	19/–
80,000	5	Ditto Pref. 6%	80/–		6	6	7 10 0	75/6	69/–	83/6	69/–
3,705,670	Stk. (£1)	Morgan Crucible A	58/6		10φ	10	3 8 6	61/3	43/6	45/–	34/–
1,000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref. ...	17/6		5½	5½	6 5 9	18/6	17/6	18/–	17/–
2,200,000	Stk. (£1)	Murex	56/9	+1/–	15	17½	5 4 0	58/3	41/–	58/9	46/–
468,000	5/–	Ratcliffs (Great Bridge)	12/9	+9d.	10R	10	3 18 6	12/9	9/6	11/1½	6/10½
234,960	10/–	Sanderson Bros. & Newbould ...	41/–		25	20	6 2 0	41/–	27/9	27/3	24/6
1,365,000	Stk. (5/–)	Serck	29/9	+3/3	17½GB	15	3 0 0	29/9	18/–	18/7½	11/–
6,698,586	Stk. (£1)	Stone-Platt Industries	60/–	+6/6	15	15	5 0 0	60/–	42/6	45/6	22/6
2,928,963	Stk. (£1)	Ditto 5½% Cum. Pref.	17/9		5½	5½	6 4 0	18/–	15/10½	16/3	12/7½
18,255,218	Stk. (£1)	Tube Investments Ord.	106/3	+1/9	17½	15	3 5 0	113/–	72/–	86/–	48/4½
41,000,000	Stk. (£1)	Vickers	32/–	+1/9	10	10	6 12 3	37/–	27/4½	36/3	28/9
750,000	Stk. (£1)	Ditto Pref. 5%	15/–		5	5	6 13 9	15/0½	14/3	15/9	14/3
6,863,807	Stk. (£1)	Ditto Pref. 5% tax free	21/3		*5	*5	6 19 0A	22/7½	20/6	23/–	21/3
2,200,000	1	Ward (Thos. W.), Ord.	138/9	+23/9	20	15	2 17 6	147/6	83/–	87/3	70/9
2,666,034	Stk. (£1)	Westinghouse Brake	53/3	+3d.	10	10	3 15 6	53/9	39/9	46/6	32/6
225,000	2/–	Wolverhampton Die-Casting ...	11/6	+1/6	30	25	5 5 0	11/6	8/8½	10/1½	7/–
591,000	5/–	Wolverhampton Metal	30/–	+7½d.	27½	27½	4 11 9	32/6	21/6	22/9	14/9
78,455	2/6	Wright, Bindley & Gell	7/1½	+6d.	20	20	7 0 6	7/6	4/11½	5/4½	2/9
124,140	1	Ditto Cum. Pref. 6%	13/9		6	6	8 14 9	13/9	12/10½	13/–	11/3
150,000	1/–	Zinc Alloy Rust Proof	3/4½		27	40D	8 0 0	3/9½	2/9	3/1½	2/7½

*Dividend paid free of Income Tax. †Incorporating Zinc Corpn. & Imperial Smelting. **Shares of no Par Value. ‡ and 100% capitalized issue. •The figures given relate to the issue quoted in the third column. A Calculated on £7 8 9 gross. Y Calculated on 11½% dividend. ‖Adjusted to allow for capitalization issue. D And 50% capitalized issue. C Paid out of Capital Profits. E and 50% capitalized issue in 7% 2nd Pref. Shares. § And Special distribution of 2½% free of tax. R And 33⅓% capitalized issue in 8% Maximum Ordinary 5/– Stock Units. ¶ Interim since increased from 10% to 12%. φ And proposed 40% capitalized issue. Z Interim since increased. B And proposed 50% capitalized issue. G And 1½d. special distribution.

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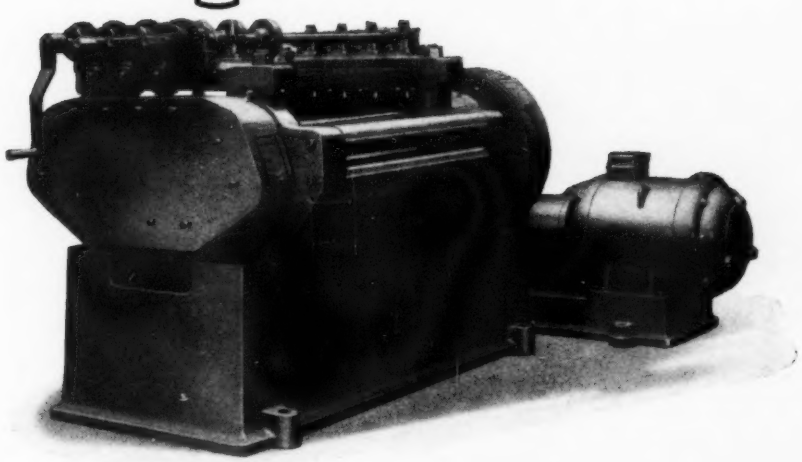

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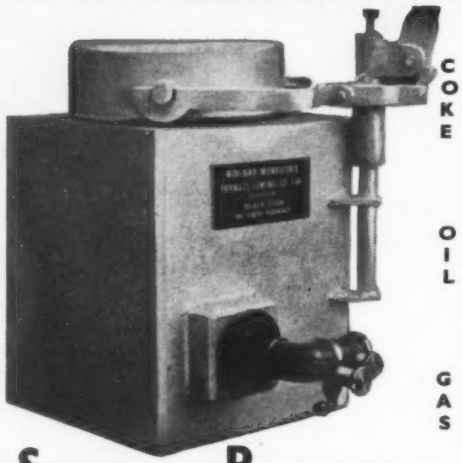

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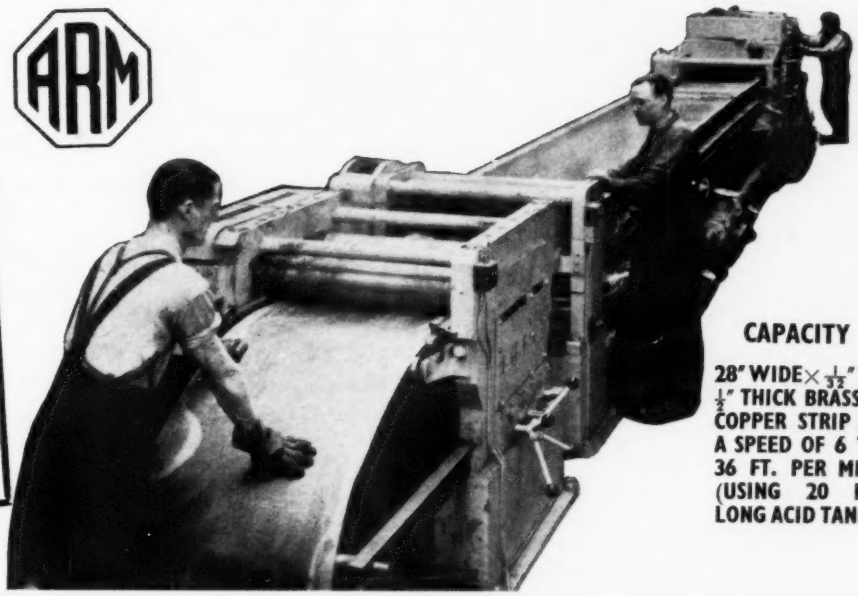

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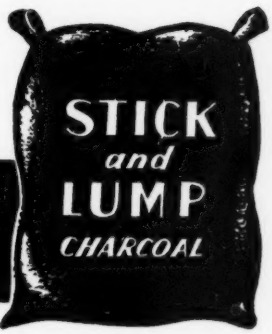

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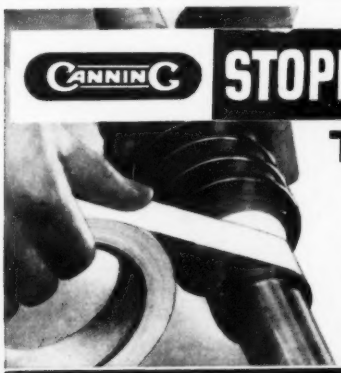

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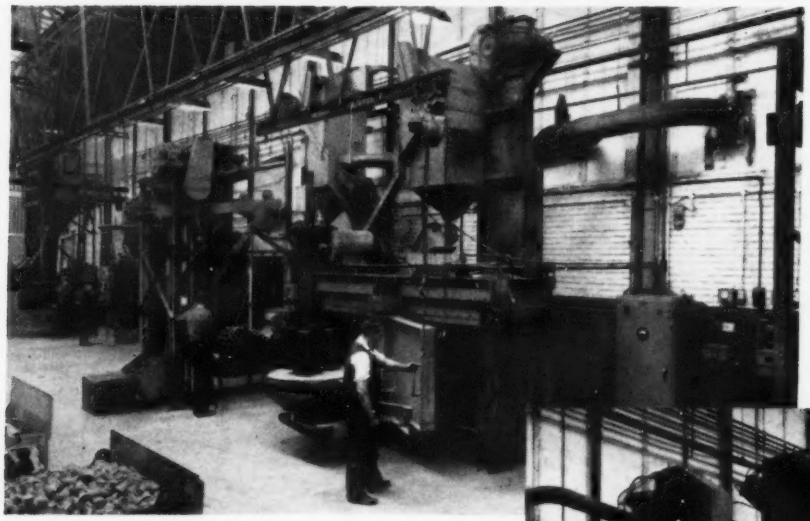

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